THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE IV. VOL. II.

No. III.—MARCH, 1895.

ORIGINAL ARTICLES.

I.—On a Collection of Fossils from the Lower Greensand of Great Chart, in Kent.

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1. The Lower Greensand of Great Chart.
2. List of the Fossils.
3. Affinities of the Fauna.
4. The value of the Sandgate Fauna.
5. The Synchronism of parts of the Gault and the Lower Greensand.

I. The Lower Greensand of Great Chart.

THE rarity and imperfect preservation of the fossils in the upper part of the Lower Greensand, in the south-east of England, has always added considerably to the difficulties in the study of that series. The Atherfield Clay and the Hythe Beds both have well-marked faunas, though fossils are often absent from the latter. The palæontological evidence is, however, much less satisfactory in the case of the two uppermost of the four divisions into which the Lower Greensand is usually divided. A fair number of fossils occurs in these at Folkestone, but further to the west the lithological nature of the beds changes, and fossils are found in but few localities.

In the "Geology of the Weald" Mr. Topley recorded (p. 129) 11 species from a quarry at Great Chart, near Ashford. The horizon was assigned to that of the Sandgate Beds because the fossils occur overlying the Kentish Rag, or limestones of the Hythe stage. As this is the westernmost point in Kent at which fossiliferous representatives of the Sandgate Beds are said to occur, the locality is an important one. I therefore made a collection of its fossils in the winter of 1889–1890, both in order that the fauna might be represented in the British Museum Collection, and in the hope of getting more information as to the palæontological value of the Sandgate Beds. The fossils occur mainly as internal casts; their identification is accordingly difficult and unsatisfactory; but as the collection includes over 140 specimens, it has been possible to fit together the evidence of several specimens of the same species, and thus to determine the most important characters.

The quarry from which the fossils have come is situated a little to the south of an old moated house—Singleton Manor. The workings are carried on for the Kentish Rag, of which 30 feet are

shown in the section. The hassock which separates the rag is more argillaceous than is usually the case. The section is as follows:—

Soil.	
Green sandy clay.	
Layer of phosphatic nodules, with fossils	1 foot.
Broken rag with many *Exogyra Couloni*	2½ feet.
Kentish Rag and Hassock	30 feet.

II. List of Fossils.

Species.	Author.	Range in Time.
	Vermes.	
Serpula filiformis	Sow.	
	Brachiopoda.	
Terebratula sella	Sow.	Neoc.† Apt. Glt.
Waldheimia Wanklyni	Walker	Apt.
Terebratella Fittoni	Meyer	Apt.
**Rhynchonella sulcata*	(Park.)	Apt. Glt.
*——— *Gibbsiana*	(Sow.)	Apt. Glt. Cenom.
	Lamellibranchiata.	
Exogyra Couloni	(Defr.)	Apt.
[Syn. *Exogyra sinuata*	Sow. *non* Lam.]	
**Neithea quinquecostata*	(Sow.)	Apt. Glt. Cenom.
**Gervillia anceps*	Desh.	Rh. Apt.
Idonearca glabra	(Park.)	Up. Apt. Low. Glt.
——— *subnana*	(Pict. and Rx.)	Low. and Mid. Glt.
Nucula albensis	D'Orb.	Mid. Glt.
**Trigonia aliformis*	Park.	Apt. Glt. Up. G. S.‡
——— *ornata*	D'Orb.	Urg. Neoc. Apt.
Astarte allobrogensis	Pict. and Camp.	Low. Glt.
Arctica angulata	(Sow.)	Up. Apt. Low. Glt.
Venus vassaicensis	D'Orb.	Low. Apt.
——— *parva*	J. de C. Sow.	Apt.
——— *galdrina*	D'Orb.	Neoc. Apt.
——— *Orbignyana*	Forbes	Low. Apt.
Thetis lævigata	(Sow.)	Apt.
Thracia, aff. *simplex*	(D'Orb.)	Low. Glt.
**Arcomya plicata*	(Sow.)	Apt.
*——— *neocomiensis*	(Leym.)	Urg. Neoc. Apt.
	Gasteropoda.	
Natica Hugardiana?	D'Orb.	Neoc.
——— *buliminoides*?	(Desh.)	Neoc.

* Species accepted on Mr. Topley's authority.

† Urg. = Urgovian; Neoc. = Neocomian; Rh. = Rhodanian; Apt. = Aptian; Glt. = Gault; Cenom. = Cenomanian; Up. G. S. = Upper Greensand.

‡ The Upper Greensand is used in this case instead of the Cenomanian, for the horizon at Blackdown, at which this fossil occurs, is probably the equivalent of the Gault and not of the true Cenomanian.

III. The Affinities of the Fauna.

Mr. Topley recorded 11 species, of which *Serpula filiformis* is a useless worm-tube, and two are excluded from the above list owing to doubt as to the correctness of their identification. These are *Exogyra conica*, a record which was probably based on a young *E. Couloni* and *Terebratula oblonga*, which probably ought to have been identified as *Terebratella Fittoni*; these two Brachiopods often, when badly preserved, resemble one another somewhat closely. Mr.

Bather has kindly examined my specimens with care, and determined them all to be *T. Fittoni*.

The above list, therefore, adds 15 species to the fauna: these are of interest as they are forms with a more restricted distribution than the 11 valid species in Mr. Topley's list. The following table shows the affinities of the species:—

Species confined to Neocomian	2	(both doubtful)
,, ,, Aptian	8	
,, ,, Gault	4	
,, ranging from Urgovian to Aptian	2	
,, ,, Neocomian to Aptian	1	
,, ,, ,, Gault	1	
,, ,, Aptian to Gault	3	
,, ,, Aptian to Upper Greensand ..	3	

This summary clearly shows that the affinities of this fauna are with the Aptian or Gault; for of the 24 species included, 18 occur in the former, and 11 in the latter, while 15 are confined to the two stages. Two species occur only in the Neocomian, but they are based only on internal casts of univalves, and their evidence is of little value. The affinity is closest with the Aptian, but the fact that 11 species are present which occur in the Gault and that three range into the Upper Greensand, point to the fauna being high up in the Aptian stage.

This is in full agreement with the stratigraphical evidence; for the bed overlies the Kentish Rag, and occurs below the Gault, though the direct superposition of the latter is not shown in the section.

IV. The Value of the Sandgate Fauna.

The fauna having been thus determined as Upper Aptian, both from palæontological and stratigraphical evidence, there remains only the question as to whether it is most allied to that of the Sandgate or that of the Folkestone divisions of the Lower Greensand, and whether there is adequate palæontological reason for the separation of these two beds.

Eight of the species in the bed at Great Chart occur in the Sandgate Beds in the district where that stage is most typically shown. All of these, however, with the exception of *Arctica angulata*, occur also in the Folkestone Beds at Folkestone; and in this there is another species (*Thetis lævigata*), found at Great Chart, but not yet recorded from the Sandgate Beds of Sandgate. Thus palæontologically the Great Chart phosphatic bed is as closely allied to the Folkestone as it is to the Sandgate Beds. It may be objected that, as of these nine species six also occur in the Hythe Beds of Hythe, Lympne and Maidstone, the palæontological evidence is too indefinite to be worth much. This, however, only proves that the Hythe, Sandgate, and Folkestone Beds represented a comparatively short period. The species characteristic of the Hythe stage do not occur in either of the latter at Folkestone or Great Chart. The Sandgate and Folkestone Beds together contain a number of species which are characteristic of a higher horizon. Such are *Waldheimia Wanklyni, Terebratella Fittoni, Rhynchonella sulcata, Astarte allobrogensis,*

Venus parva, etc. The three Brachiopoda nearly always occur in the upper part of the English Lower Greensand, when this is fossiliferous, as in the Bargate Beds near Guildford, and in the outliers at Faringdon and Upware. These five species may be taken as typical of the stage between the Hythe Beds and the Gault. They do not, however, support the division of this interval into two. The faunas of the Folkestone and Sandgate Beds at Folkestone, have been shown by further collecting to be practically identical. The differences between them appear to be only a lithological accident. The collection from Great Chart confirms this view, as the fauna is equally allied to each of the other two.

Objections to the identification as Sandgate of sundry isolated patches of rocks in the Lower Greensand of Western Kent and Surrey, have frequently been raised. These seem fully justified by the palæontological evidence which supports the following triple division of the Lower Greensand deposits of the South-east of England:—

1. Upper Aptian or Gargasian, including	Folkestone Beds of Folkestone (excluding the *mammillare* zone). Sandgate Beds. Phosphatic Beds of Great Chart. Bargate Beds of Guildford. Fuller's Earth Series of Nutfield. Faringdon Sponge Gravels. Lower Greensand of Upware and Bedfordshire.
2. Lower Aptian or Bedoulian	Hythe Beds and Kentish Rag. Main Chert Series of Godalming, Hindhead, Ewhurst, and Leith Hill.
3. Rhodanian...	Atherfield Clay.

V. The Synchronism of Parts of the Gault and the Lower Greensand.

Hitherto it has been generally assumed a change from the deposition of sand to that of clay, marked the division between the times of the Lower Greensand and of the Gault. The sands below a certain line are called the "Folkestone Sands" and are included in the Lower Greensand; the clay immediately above it is regarded as marking the commencement of the Gault. In the Geological Survey maps this lithological change is taken as the line of separation of these two series. For their purposes, this is the only possible and practically useful course that could have been adopted. The palæontological evidence is too difficult in application. But when this lithological line is accepted as the definite time limit between the periods of the Gault and the Lower Greensand, it is necessary to demur. Another explanation is possible.

Mr. Meyer showed,[1] more than twenty years ago, that the Upper Greensand of Blackdown is really Upper Gault; M. Barrois[2] has

[1] C. J. A. Meyer, "On the Cretaceous Rocks of Beer Head . . . ." Quart. Journ. Geol. Soc. vol. xxx. 1874, p. 385.

[2] C. Barrois, "L'âge des couches de Blackdown (Devonshire)," Ann. Soc. géol. Nord. t. iii. 1876, pp. 1–8. "Recherches sur le terrain Crétacé supérieur de l'Angleterre et de l'Irlande," Mém. Soc. géol. Nord. t. i. 1876, p. 69.

fully supported this conclusion. Mr. Jukes-Browne[1] has also recently pointed out that the Upper Greensand of Western Wiltshire is really only a calcareous sandy facies of the Gault. Similarly it is possible that the change from the sands characteristic of the Lower Greensand to the clays characteristic of the Gault, happened later in Surrey and the West of Kent than it did on the east coast. If so, then the "Folkestone Sands" of Guildford and Dorking were still in process of deposition after the formation of the last of the Folkestone Beds, and while the Gault was being laid down in the east of Kent.

This question cannot be finally answered until a collection of fossils has been made from the very base of the Gault in Eastern Surrey, sufficient for the determination of the exact zone to which this belongs. On the ordinary assumption, it ought to be the zone of *Hoplites interruptus*. There are, however, reasons to believe that this zone is absent from the area to the south of London. In spite of having watched whatever exposures of Gault I could find along the line between Guildford and Caterham, I have never been able to find any Ammonite belonging to a zone lower than that of *Hoplites splendens*. Nor can I find any reliable record of the occurrence there of the fossils of the lower zones.

Hoplites interruptus seems restricted in England to the Folkestone area and the Red Chalk. It has, however, been recorded[2] from the Richmond boring. If this record be correct, so probably also is the ordinary assumption as to the age of the "Folkestone Sands" of Surrey. The fossil is stated to have come from the depth of 1100 feet, while *Hoplites splendens* is recorded from a depth of 1128 feet. Such an inversion of the zones seemed improbable, and this led to a search for the specimen on which this record was based. The specimen is now in the British Museum (Natural History), and Mr. G. C. Crick has kindly examined it. He reports that though much broken its characters are distinct, and it is unquestionably not an *Hoplites interruptus*, but a specimen of the large fluted form of *H. splendens*. The *interruptus* zone is therefore still unrecorded from the London area or to the south of it.

The *Ammonite* in the core from the depth of 1128 feet is, however, also a typical specimen of *H. splendens*, and occurs only 13 feet above the base of the Gault. This species ranges from the 4th to the 7th zone of the Gault. If we make the somewhat improbable assumption that this specimen came from the very lowest possible point at which it could have occurred, then zones 1–3 are reduced to a thickness of only 13 feet. Thus either the three basal zones are proportionally much thinner at Richmond than they are at Folkestone, or else one or more of them is there absent. The latter view appears the more probable, as it explains the absence of the fossils of the same three zones from the line between Guildford and Godstone. If so, as in this area, there is no unconformity between but a gradual

[1] A. J. Jukes-Browne, "The Geology of Devizes, with Remarks on the Grouping of Cretaceous Deposits," Proc. Geol. Assoc. vol. xii. 1892, pp. 264–266.

[2] Quart. Journ. Geol. Soc. vol. xl. 1884, p. 736.

passage from the Folkestone Sands to the Gault, these three zones must be represented by part of the former. Then the commencement of the "epoch" of the Gault is represented not by the base of the fossiliferous clays but by some part of unfossiliferous sands now included in the Lower Greensand.[1]

This proposal is not altogether a new one, for the view was long ago expressed that part, if not all, of the Folkestone Beds of Folkestone must be included with the Gault. Thus Gaudry[2] advocated this in 1860, and he has been followed by many Continental authors and by Prof. Cole.[3] This step has not, however, been generally accepted, owing to the difficulty of separating the *Ac. mammillare* zone from the rest of the Lower Greensand. Thus M. Barrois maintains that we must include in the Gault, not only the Folkestone, but also the Sandgate and Hythe Beds, owing to the unity of the faunas of these three horizons; and that as they contain the zone of *Ac. mammillare*, they therefore belong to the Gault. He says,[4] "il est hors de doute que la partie supérieure de ce Lower Greensand (*Folkestone Beds*) est notre zone de sables verts à *Am. mammillaris* . . . . . ils [the fossils of this zone] sont tous du gault, et ce niveau ne peut être séparé du gault." And he proceeds: "Si les Folkestone beds appartiennent au gault, les Sandgate beds, Hythe beds, qui n'en diffèrent que d'une façon insensible, devront aussi appartenir au gault; on ne peut songer à mettre une division d'étage au milieu du Lower greensand."

Acanthoceras mammillare does not occur in the Lower Greensand except in the uppermost of the four divisions into which Price has divided the Folkestone Beds.[5] This narrow zone must be included in the Albian and regarded as part of the basement bed[6] of the Gault; but only this. The three lower divisions of the Folkestone Beds and the Sandgate Beds, as well as the Hythe, are all below the horizon of *Acanth. mammillare* and are therefore earlier than the Albian.

The following Table expresses the views here advocated of the relations of the Lower Greensand and Gault in Kent and Surrey:—

This Table illustrates the differences between the formation scale and the time scale. For the purposes of the map the separation of the Gault and the Lower Greensand is of course necessary. But

[1] At a recent meeting of the Geological Society, Mr. T. Leighton announced the discovery of a fossil in the Folkestone Sands. This is a cone which has been identified by Mr. Carruthers as *Pinites hexagonus*, Carr. (Geol. Mag. 1871, Vol. VIII. pp. 540–544, Pl. XV.), a species previously known from the Upper Gault (zone ix.) of Eastware Bay. It is interesting to find that the only known fossil from the Folkestone Sands inland is a Gault species.

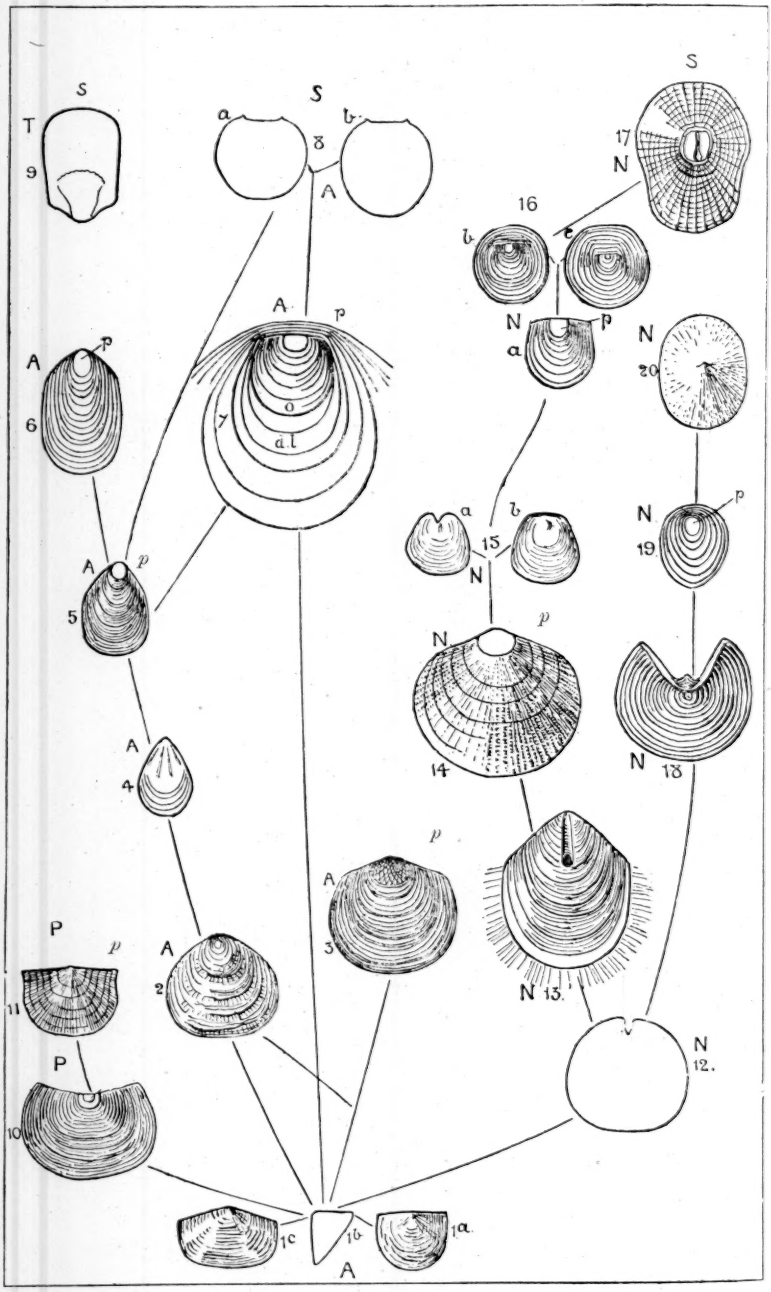
[2] A. Gaudry, "Sur la découvert de l'*Ostraea Leymerii* à Wissant (Pas-de-Calais)," Bull. Soc. géol. France, sér. 2, t. xvii. p. 32.

[3] G. A. J. Cole, "Aids in Practical Geology," ed. 2, 1893, p. 387.

[4] C. Barrois, "Sur le Gault et sur les couches entre lesquelles il est compris dans le bassin de Paris," Ann. Soc. géol. Nord. t. ii. 1875, p. 56.

[5] F. G. H. Price, "On the Lower Greensand and Gault of Folkestone," Proc. Geol. Assoc. vol. iv. 1875, p. 139.

[6] The frequent "very decided passage from one to the other" (*i.e.* Folkestone Beds to Gault) has been pointed out by Mr. Topley. "On the Lower Cretaceous Beds of the Bas-Boulonnais." Quart. Journ. Geol. Soc. vol. xxiv. 1868, p. 474.



Stages of generic development of Brachiopoda.

for other questions, such as that of the migrations of the Lower Cretaceous faunas, a time scale which is independent of lithological characters is equally necessary. These two scales are not contradictory, but complementary, and each must be retained for its special purposes—the one for local purposes and the other for a universal

Time Division.	Representatives in East Kent.	Representatives in Surrey.	Characteristic Species.
Albian.	Gault: Upper Zones, Nos. 4 ?–9. Gault: Lower Zones, Nos. 1–3 (+ x ?). Folkestone Beds. *Ac. mammillare* Zone.	Gault. "Folkestone Sands," or "Upper Ferruginous Sands."	*Hoplites splendens*, etc. *Hoplites interruptus*, etc. *Acanth. mammillare.*
Upper Aptian.	Folkestone Beds (Divisions I.–III. Sandgate Beds, and Phosphate Bed of Great Chart).	Bargate Stone. Nutfield Fullers' Earth Beds, etc.	*Waldheimia Wanklyni.* *Terebratella Fittoni.* *Rhynchonella sulcata.* *Avicula pectinata.*
Lower Aptian.	Hythe Beds (Kentish Rag, etc.)	Main Chert Series. Lower Ferruginous Sands.	*Waldheimia tamarindus.* *Acanth. Cornuelianum.* ——— *Martini.* *Hoplites furcatus*, etc.
Rhodanian	Atherfield Clay.	Atherfield Clay.	*Aporrhais Robinaldina*
Neocomian	Weald Clay, etc.	Weald Clay, etc.	

time scale. Thus they correspond in history to the methods of dating events by dynasties or by centuries. If this be understood there need be no confusion between them, though the statement that part of the Lower Greensand is Gault, sounds like saying that this week is part of last week. But we can say without such paradox, that part of the Lower Greensand is of Albian age, though that stage is in England typically represented by the Gault.

II.—The Evolution of the Brachiopoda.

By Agnes Crane.

(PLATE V.)

(*Continued from the February Number*, p. 75.)

Part II.

IT is evident that neither Barrande nor Davidson, who maintained the opinions I have summarized till the last in their publications, were able to recognize the evidence deducible from a study of the Brachiopoda favourable to the theory of their evolution.

The solution of the problem was left for a contemporary worker in the same field of inquiry, and for the younger school of American brachiopodists versed in all the modern methods of embryological

and palæobiological research. The veteran is Professor James Hall, Director of the Geological Survey of the State of New York, that excellent training-ground for such able palæontologists as Whitfield, Walcott, and Clarke. Beecher and Schuchert, we believe, also studied Brachiopoda at Albany in Hall's private and State collections. It was at Albany that the Memoir on the Development of some Silurian Brachiopoda, by Dr. C. E. Beecher and Mr. J. M. Clarke (14), was published in 1889.

The material for this Memoir was derived from a collection weighing seven tons. From this fifty thousand specimens of Brachiopoda were washed out, sifted, selected, and referred to their respective genera and species. The horizon was that of the Niagara shales of the Upper Silurian formation; locality, Waldron, Indiana, U.S.A. All stages of growth of the individuals of a species were thus obtained. Some of these, if found by different observers in various localities at other times, might well have been referred to distinct species, whereas when placed in a line with the smaller and larger examples of their species the relationship becomes at once apparent, and the individuals fall into their place in the natural series.

From their laborious research the authors, Messrs. Clarke and Beecher, deduced the highly suggestive conclusion that the early stages of species belonging to such distinct groups as *Rhynchonella*, *Spirifer*, *Athyris*, *Nucleospira*, and the Meristoids, resemble each other so closely that the genera can then be determined only by comparatively trivial features.

This Memoir was followed, in 1892, by that remarkable "Introduction to the Study of the Palæozoic Brachiopoda," by James Hall and J. M. Clarke (38), which bids fair to become the Bible of the brachiopodist, and to revolutionize the study of the Brachiopoda in general. And it is to Albany that we now look for the completion of those fruitful studies in the generic evolution of this ancient Class.[1]

Our knowledge of the larval and later stages of individual growth in the living species is mainly due to the investigations of Fritz Müller, McCrady, Morse (56, 57), Brooks (12), Beyer (10), Shipley, Schulgin, Kowaleveski, Lacaze-Duthiers (51), Friele (36), Eugène Deslongchamps (33), Dall, Beecher (4, 5), and Fischer, Daniel and Pauline Œhlert (59, 60, 61).

It is, therefore, to Hall and Clarke that we owe the most searching inquiry into the genetic relationships and characteristics of the numberless ancient fossil forms of the class (38), and to Beecher and Clarke (14) important and suggestive studies in individual or ontogenetic development of Silurian species, and to the first-named correlations in ontogeny with phylogeny (8).

[1] The main text of part ii. vol. viii. Brachiopoda (Palæontology of New York) has since been issued. The printing of the volume of quarto plates is, we regret to learn, still delayed, through no fault of the authors. We have been favoured by Professors Hall and Clarke, since the first part of this paper went to Press in January last, with advance sheets of their "Summary of the Evolution of the Genera of Palæozoic Brachiopoda," destined to accompany the volume of Plates, and thus to complete their masterly survey of the Brachiopoda.

Let us now summarize the principal results of these combined studies from "the life" and from "still life," for the palæobiologist begins his inquiries at the point where those of the embryologist usually terminate.

We find that complex or synthetic types are by no means rare. The farther back we search the geological records the greater is the number of types uniting characters which subsequently become differentiated and accentuated, and serve to distinguish the diverse members of widely separated families.

The occurrence of genera with such mixed characters that descriptive palæontologists of the older school found it difficult to determine to which of two families they should be referred [1]—as Davidson sometimes frankly lamented,—coupled with the frequently expressed difficulties of separating many so-called species, should have originated doubts as to successive specific or generic creations.

Reversionary types are also met with which exhibit a tendency to go back to some earlier adult phase of genetic characterization. Such living "atavistic" types are *Gwynia*, *Cistella* among Megathyrids, and *Dyscolia* among Terebratuloids, *Atretia* (17) of the Rhynchonelloids, *Rhinobolus* among the fossil Trimerelloids, and *Aulosteges* among the Productoids.

The study of the individual development of larval forms of different species reveals past phases in the history of the evolution of the genus to which they belong, and its ancestral relationships. It becomes evident that these successive transitional stages were often stereotyped as adult genera fossilized in the records of the rocks. If this can be demonstrated of one branch, one order of Brachiopoda, we maintain that it follows logically that the principle is true of all branches, although the methods and lines of variation may have deviated. In other words, the same goal is reached by travelling different ways, as can be actually proved in more than one instance.

Now, it is impossible to deny that such a successful demonstration has been accomplished through the combined results of various researches on the structure and development of the recent Terebratuloids by Friele (36), Deslongchamps (34), Morse (57), Dall (24), the Œhlerts (59, 61), and Beecher (4), and for the Palæozoic Brachiopoda by Hall and Clarke (38). From Clarke and Beecher's (14) studies of a large series of individuals of several Silurian species we may also learn how easily abnormal forms originate at different periods of individual growth, and that these direct and indirect divergents, due to physiological causes accelerated by the environment, may give rise to new generic or subgeneric forms. The descendants of these generic variants, again prematurely

[1] This difficulty becomes naturally most apparent when treating of the Primordial and later Palæozoic genera, and is less marked among later developments. Hall and Clarke, as is well known, consider the employment of family groups, and even broader divisions, as "so palpably a violation of nature's method as to make itself felt as an incumbrance," and therefore use them merely as conventional and convenient.

launched into the sea of life, perpetuated a race of individuals with the same accelerated characters and propensities (3).

Furthermore, we discover as we proceed with our inquiries, that such distinctions as are expressed in the class names *Lyopomata* or "loose valves," comprising all the genera with inarticulated valves, and the *Arthropomata*, or "attached valves," including all those with articulated valves, are not in reality fundamental distinctions. It is now known that some forms of Brachiopoda once existed which fairly bridged the gulf, formerly considered impassable, between these two natural groups of hinged and hingeless forms, and that in more than one direction. We may cite as examples, *Neobolus*, *Spondylobolus*, *Trematobolus*, and *Kutorgina* of the Cambrian period, *Trimerella* and *Monomerella* of the Silurian, and *Barroisella* of the Devonian (*Lingula subspatulata*, M. and W., type), which indicate different approximations between the hingeless and the hinged forms (38). The fact, moreover, that Mr. G. F. Mathew (52) was compelled to describe his new genus *Trematobolus* from the St. John horizon in North America as an articulated Brachiopod of the order Inarticulata, emphasizes this point in a very marked manner.

Let us now briefly consider some of these recent genealogical revelations. It will, I think, be generally admitted that each distinct group of Brachiopoda is first represented by small species, somewhat insignificant in size and number of genera, although perhaps rich in species and individuals in favourable localities.[1] In 1877 Dall (26) and Davidson (24) estimated the number of known genera at 130, dividing them respectively into eighteen and fourteen family groups. In 1887 Fischer and D. and P. Œhlert (63) admitted sixteen. This year Mr. Charles Schuchert (64) took a fresh census, tabulated 279 genera as valid, and classed them into forty-seven family and sub-family groups. Two-thirds of these were differentiated in the Palæozoic era, ranging from the Primordial to the Carboniferous and Permian inclusive. But only nine of these passed up into the Mesozoic, when, however, some fresh types appeared which gave rise to a secondary evolution on fresh lines of development. Six out of the *seven surviving* families were represented in the Palæozoic. The genealogy of the Thecidiidæ is interrupted at the Carbo-Permian epoch, but there is good reason to believe that their remoter ancestors lived as long ago as the Silurian.

The Cuvierian class Brachiopoda is still subdivided by Beecher (4) and Schuchert (64), Fischer and the Œhlerts (63), into the sub-classes *Lyopomata* and *Arthropomata* of Owen, as the distinction of loose and attached valves is one which conveniently characterizes an immense majority of the described forms. The sub-classes were again subdivided into six orders by Waagen (68) in 1883, into eight by Neumayr (58), and by Dr. Beecher (4) into four in 1891. His classification (5) seems a rational one, based on the nature of the pedicle-passage and certain stages of shell growth. It embodies some of the best features of the systems of Von Buch, Deslongchamps (33, 34, 35), King (48), Gray, Davidson (28), Dall (25,

[1] *Stringocephalus* and *Schaphiocœlia* are abnormal exceptions.

26), Waagen (68), Hall (38), Barrande (1), etc., as considerably extended and emended of late by Schuchert (64, 66).

The ATREMATA, with a free pedicle-passage between both valves, are the oldest and simplest forms of Brachiopoda, represented in the Lower and Middle Cambrian by *Paterina*, *Obolella*, etc., but *Lingula*, a surviving type, did not appear before the Lower Silurian period.

Of the twenty-four known hingeless atrematous genera, no less than nine appeared in the Primordial fauna. Of their immediate ancestors, as yet we know nothing. Twenty-two in all appeared during the Palæozoic era. Two little "tongue-shaped" shells still represent them—*Lingula* in the Eastern oceans and *Glottidia* in those of the Western hemisphere.

The ATREMATA gave rise almost simultaneously in the Primordial seas to members of the orders Neotremata and Protremata; for types it is now generally conceded are more plastic at or near their points of origin.

The NEOTREMATA comprises all the disc-like hingeless forms with pedicle passage restricted to the ventral valve. These diverged from the ATREMATA by way of the round punctured shells of the family of the Trematidæ. Thirty-one genera are referred to this order, which is represented in existing oceans by the long-lived *Crania*, *Orbiculoidea*—also known as *Discina*,—and by the modern branchlet of *Discinisca*.

The order PROTREMATA includes the large number of 82 articulated genera with a single plate deltidium, classed by Schuchert (64) into two suborders[1] and fourteen families, many with but a short range in time. The earliest forms of the primary division are considered to have originated from the ATREMATA, *viâ* the Cambrian species allied to the genus *Kutorgina* (*K. cingulata*, Billings, type), and were chiefly restricted to the Palæozoic oceans. Others appeared at the close of that great epoch, or with the dawn of Mesozoic time. The only direct living representative of the PROTREMATA, as defined by Beecher, is the Thecidoid *Lacazella Mediterranea*, Risso. Other members of the family to which this species belongs are known to occur in the Jurassic, possibly in the Trias. Then there is a break in continuity of descent, but there is good reason to believe that the remoter ancestry of the Thecidiidæ will eventually be traced through the adhering Productoids back to the Silurian Strophomenoids, which have the same habit of attaching themselves by one valve to foreign objects, or, like many neotrematous genera, to each other.

It was from the PROTREMATA, prolific in short ranging genera, that the important order of TELOTREMATA originated in that family of Pentameridæ, abundantly represented in Silurian seas, and it is believed by the genus *Camarella* in the Primordial oceans. It diverged in two main lines of descent, with numerous collateral

[1] I. *Trullacea*, from *trulla* a scoop, for the spoon-shaped plate, the spondylium of Hall.

II. *Thecacea*, from *theca* a cover, referring to the deltidium in one plate covering the three-cornered fissure in the apical portion of the ventral valve.

branches, one of the extinct Spiriferoid, Meristoid, and existing Rhynchonelloid, and the other of the Terebratuloid type, still more familiar. By far the largest number of Brachiopoda—half of all the known genera—belong to this order of TELOTREMATA,[1] which is characterized by the deltidium in two plates, and the presence of variously modified calcified supports to the brachial or breathing organs of the "arm"-footed mollusc-like animals.

Thus, to sum up the ordinal relationships, the atrematous order represents the short main trunk of the Brachiopodal phylum—the NEOTREMATA and PROTREMATA chief divergent, but now dwindling branches, while the secondary, but more robust branch of the TELOTREMATA, which originated in the PROTREMATA, has given rise to more numerous stems, branchlets, and offshoots than all the rest put together. By far the larger number of surviving genera and species belong to this flourishing branch of the Brachiopodal family tree.

So much for the ordinal evolution of the Brachiopoda, which has been indicated in the diagram already published (Plate IV.), in which the top line represents the seas of the present day, and the bottom one the Primordial oceans of long past ages (GEOL. MAG. p. 65, February, 1895).

Let us now consider some instances of the evolution of genera.

The simplest form of all known Brachiopoda[2] is that small semi-elliptical, horny, imperforate hingeless shell *Paterina*, the little father of all the Brachiopoda. The genus was founded on a Lower Cambrian species first referred to *Kutorgina* and *Obolus* by Billings and Walcott,[3] but assuredly not belonging to the first-named genus if *Kutorgina cingulata*, Billings, from the Middle Cambrian be taken as its type, for that is a calcareous shell with indications of a hinge-area, and there seems reason to consider it as an ancestral form of the articulated PROTREMATA (Pl. V. Fig. 10.)

In external shape the atrematous *Paterina* (Pl. V. Figs. 1*a*, *b*, *c*) bears a close resemblance to the horny imperforate protegulum, or earliest developed shell covering, which makes its appearance in the phylembryonic stage (when class characters can be first determined with certainty) of all larval Brachiopoda. According to Beecher, nearly every Brachiopod goes through a "paterine" stage of development (5). The Primordial little "coin-shaped" shells known as *Obolella* (Fig. 2) pass through their transient paterine stage, and the resultant Obolelloids play an important part in the genealogy of *Lingula* (Figs. 5, 7), one of the few "tongue-shaped" shells of the atrematous order still existing. For the Linguloid type was evidently derived from the preceding Obolelloid which had attained

[1] The earliest known forms of the telotrematous sub-orders ROSTRACEA, HELICOPEGMATA, and ANCYLOBRACHIA approximate. There is reason to believe that the ROSTRACEA and ANCYLOBRACHIA are older than the HELICOPEGMATA or SPIRIFERACEA.

[2] "And it might be fair to say of all possible Brachiopoda"—add Hall and Clarke (*op. cit.* p. 912, 1895).

[3] The earliest form and type species is *Paterina Swantonensis*, Walcott, sp., from the Lower Cambrian of Vermont, first described as *Obolus* (*Kutorgina*) *Labradorica*.

its culmination, or period of maximum development, in a faunal epoch antecedent to the appearance of the true *Lingula*, which is therefore not the most ancient form of all the Brachiopoda (38).

Prof. W. K. Brooks had long since noted the Obolelloid shape of the shell in the larval phases of recent *Lingulæ* (*Glottidia*) (12), just as a Linguloid phase of shell growth had been previously recognized by Morse as characterizing an early stage of *Terebratulina septentrionalis* still living on the east coast of Maine (Pl. V. Figs. 8*a*, 8*b*, and Fig. 9) (56, 57).

When we consider the tendency to abbreviation, which is a general feature of later embryological stages, it is astonishing that palæontologists should have been able to trace so many satisfactory genealogies.

The Lower Silurian true *Lingulæ* gave rise to many generic ramifications, some of which were short-lived. Two genera—*Lingula* and the divergent *Glottidia*—survive in existing oceans, the first on the eastern, the second on western shores, both in shallow waters.

Some of the early Lingulelloids, such as *Lingulella* (Pl. V. Fig. 4) and *Lingulepis*, fore-runners of *Lingula*, were of a very mixed type, having the outward form of *Lingula* combined with the narrow pedicle slit and simple muscular arrangements of the antecedent Obolelloids (38). While *Trematobolus* from the St. John group has been described by Mr. G. F. Mathew as an "articulated Brachiopod of the Inarticulate order," it combines the features of *Siphonotreta*, *Schizambon* (Fig. 13), and *Obolus* in the ventral valve and those of *Orthis* in its dorsal valve (52, 53).

Hall's new genus *Barroisella*, a lineal descendant of Silurian *Lingulæ*, is an illustration which survived in Devonian seas of *one* way in which the hingeless loose valves approach the articulated or attached valves. It presents so marked a specialization of the deltidial callosities as to indicate their approximation for articulating and interlocking purposes. This genus left no descendants.

In *Lingulops* (Pl. V. Fig. 6) and *Lingulasma*, now raised into family rank by Winchell and Schuchert (64), we get proofs of the influence of physiological causes on the origin of genera. They are said to be "platform bearing" *Lingulæ*, outwardly resembling *Lingula*, while their internal structure yields evidence of their actual relationship with the Silurian Trimerelloids. It took a Canadian (Dr. Billings), several Americans (Hall, Meek, Whitfield), a Swede (Dr. Lindström), the canny Scot (Davidson), and that far-seeing Professor of Queen's College, Galway, William King, a slayer of *Eozoon* organism, and one of the most philosophical of British writers on Brachiopoda, to decipher the enigma of these strange fossils. I was present at their introduction to the scientific world. The structure and affinities of the group were first made known in detail at the Brighton Meeting of the British Association in 1872, when Davidson read a joint paper by himself (32) and William King (49), and James Hall led the discussion.

These thick-shelled Trimerelloids may, perhaps, be regarded as the "dyspeptics" of the Brachiopod race, inasmuch as the large size

and consequent displacement of the organ usually called "the liver" (stomacal gland of Joubin) (47) affected the position of the muscles, which grew strong in proportion as the shells grew massive. The combination of increased muscular energy and resulting augmented secretion of shelly substance or "stereom" in the area of muscular attachment caused the formation of a solid plate, which has been gradually changed into a more or less vaulted platform. The evolution proceeded on two distinct lines. One deviated from *Lingula*, travelled *viâ Lingulops* and *Lingulasma*, with muscular scars excavated or sunken as in *Lingula*. The other diverged from Primordial *Obolus* through *Elkania* to *Dinobolus* with elevated muscular attachments. Both lines culminated in the Trimerellidæ before the close of the Silurian period in Canada, the United States, and Gotland, Sweden (32).

Similar instances of development on parallel lines can be traced in the longer known families of the Rhynchonellidæ and the Terebratellidæ (King *emend* Beecher). It has been clearly demonstrated by Deslongchamps (34), Buckman and Walker (13), that the "acute," the four-cornered, the "spinose," and some other Rhynchonelloid groups of the Jurassic period—I now quote *verbatim*—"carry on as they ascend each their own course of development side by side." The earliest forms of the intermediate Proto-rhynchoids are found in the Lower Silurian.

The results of the various researches into the development of the Terebratuloids have been so recently summarized by myself[1] in this MAGAZINE and elsewhere, that it is not necessary to go into details of what may truly be regarded as a test case of the evolution of the Brachiopoda.

Friele (36), Dall (24), Deslongchamps (28, 29), and Beecher (7) have traced the specific development of the northern members of the long-looped Terebratellidæ, and those of the southern oceans have been the subject of detailed comparison and research by Dr. P. Fischer, and those excellent French Zoologists Daniel and Pauline Œhlert (59), whose collaboration has been so fruitful in research, and is full of promise for the future.

It is with pleasure I refer to Madame Pauline Œhlert as an earnest co-worker with her distinguished husband, and, so far as I am aware, the only other member of my sex who is actively interested in the study of the recent and fossil Brachiopoda (59, 60, 61, 62, 63).

So far as the Terebratelloid branch is concerned the combined results of all investigations reveal two lines of generic evolution. One travelled by the northern and the other by the southern species of the family. In each the earlier stages, gwyniform and cistelliform, are identical, and indicate descent from a common Megathyrid source (7, 8). The northern forms pass successively on through the platidiform, ismeniform, mühlfeldtiform, terebratelliform, and culminate in the dalliniform phase represented in boreal

[1] GEOL. MAG. Dec. 3, 1893, p. 321. Natural Science, vol. ii. No. 11, Jan. 1893, pp. 46–52.

oceans by *Waldheimia septigera* and *Macandrevia cranium*. The austral species diverge, after assuming the cistella stage, through a bouchardiform, mergerliniform, magasiform, magaselliform, terebratelliform, and magellaniform phase, of which the fine Falkland species *Magellania* (*W.*) *venosa*, Sol., is the type of final evolution (59. 61).

These forms or phases, transitional and successive, in the living species often represent adult stages known to be permanently stereotyped as characteristic genera in the fossiliferous deposits of the Tertiary, Cretaceous, and Jurassic formations. In the Devonian epoch the Terebratelloid branches become merged in the main stem. The well-marked Devonian genus *Tropidoleptus*[1] is, according to Hall, a true platidiform type, and one of the oldest known representatives of the Terebratellidæ, while *Cryptonella*, also of Devonian age, is likewise regarded by him as a direct ancestor of the Magellanian stock (*Waldheimia*). There is evidence that both branches originated in the earlier "stropho-orthoid" stock of the protrematous order. The annectent genus *Amphigenia*, on the other hand, approximates both to the Rhynchonelloid branch and the main Terebratuloid stem, as represented by the Lower Devonian *Rensselœria*, "half Pentameroid, half Centronelloid," and others of the centronelliform type. Its appearance in the Upper Helderberg series of the Lower Devonian somewhat antedates that of *Rensselœria*. *Amphigenia* is punctate and unites the muscular scars of the Terebratuloid with a spondylium and the brachial processes of a Rhynchonelloid, and thus connects the Pentameroids with the Terebratuloids. Among the earlier orthidian and pentamerine stocks the Proto-rhynchoids also originated in Lower Silurian times, culminating in the persistent Rhynchonelloid stem, still represented by the more modern offshoots *Hemithyris* and *Acanthothyris* of the Telotrematous order, so prolific near its source in the comparatively short ranging spire-bearing genera, of which the last representatives died out in the Triassic oceans.

But it is impossible, even in the generous space limits permitted, to go farther into details of descent with modification among the Brachiopoda. We have seen, as we search together the records of the ancient fossiliferous rocks, how the confines of the *classes* merge into one another, that *orders* converge and certain *genera* pass almost insensibly the one into the other.[2] Our knowledge has, indeed, advanced with giant strides of late, thanks to the critical and searching investigations of the numerous able scientists of diverse nationalities interested in this group of organisms, and to those of America, France, and Germany in particular. I feel sure that there is awaiting us in the not far distant future a complete demonstration of the evolution of the Brachiopoda.

[1] This genus has no deltidium on the brachial valve.

[2] "Even among the generic groups there is so often an almost intangible transition from one to another that the employment of distinctive terms seems at times quite perfunctory; but with the increase of such difficulties the nearer our classification may be regarded as approaching the true method of development."—*Vide* p. 908, Hall and Clarke's "Handbook of the Brachiopoda," Part II. Albany, 1895.

Note.—"The Brachiopoda need not detain us long," writes Prof. S. J. Hickson, M.A., D.Sc. Lond., on p. 115 of "The Fauna and Flora of the Deep Sea," 1894 (Modern Science Series). It is, perhaps, just as well they did not, for we fail to comprehend his subsequent remarks thereon in the light of modern research. "*Atretia*," he proceeds, "is the only genus peculiar to deep water." If by "peculiar" he means that the genus is found in deep water exclusively (the usual sense of the word) we would refer him to the types of *Atretia Brazieri*, Davidson, which have been preserved for some years in the Davidson Collection in the Geological Department of the Natural History Branch of the British Museum. This Australian species was determined, named, and described by Dr. Davidson (see Proc. Zool. Soc. Lond. p. 181, April, 1886), for his "Monograph on the Recent Brachiopoda" (Trans. of the Linn. Soc. of Lond. 1886–1888, vol. iv. Zoology, p. 175, pl. xxv. figs. 16, 17*a*). Therein he will find the Australian species of the genus was obtained by Mr. John Brazier off Port Stephens, New South Wales. in twenty-five fathoms, which can scarcely be regarded as "deep water." Much has been learned and published with regard to the distribution of the recent Brachiopoda since the publication in 1880 of Dr. Davidson's "Report on the Brachiopoda of the Challenger Expedition," which was the first issued.

With regard to Prof. Hickson's further statement as regards *Lingula*, moreover, it can no longer be maintained "that shells almost identical with those of the living species are found abundantly in the Cambrian strata." It has been repeatedly observed in recent years by Hall, Clarke, Beecher, and Schuchert that *true Lingulæ* first appear in the Trenton series of the Lower Silurian epoch. The Cambrian species, formerly referred to that genus, are now known to belong to more primitive genera, *Lingulella* and *Lingulasma*, and that these were preceded by various Oboloids and Obolelloids and the radical *Paterina*. If the diagram of generic evolution which accompanied the first part of my paper in the February Number of this Magazine dispels the persistent illusion respecting the primeval antiquity of the genus *Lingula*, and its unchanged persistence since early Cambrian time, it will have served its turn. Of the manifold imperfections of that "attempt to indicate the ordinal and main generic relations of the Brachiopoda," no one can be more aware than the writer. Since its publication I have been favoured, through the kindness of the authors, Professors James Hall and John M. Clarke, with advance sheets of the final chapter—"the Evolution and Classification of the Genera of the Brachiopoda"—of their excellent "Handbook of the Brachiopoda," now on the eve of publication in America. The classification appended is a judicious and compact one, combining their own views with those of Waagen, Beecher, and Schuchert. Including *Paterina*, which is placed outside the pale of both the sub-classes Lyopomata and Arthropomata, as belonging exclusively to neither, but a parent source of both, and excluding *Eichwaldia* and *Aulacorhynchus* as "Incertæ Sedis," no less than three hundred and

twenty-seven genera are recorded therein. They are grouped in thirty-five families. Subfamilies are not recognized. This is about one-fourth less than Mr. Schuchert's scheme required, but the actual number of genera has been increased by forty-eight, viz. from 279 to 327, of which, strictly speaking, not one "persists unchanged" from the Lower Cambrian to the recent period.

We may be permitted to quote in conclusion the words of Professors Hall and Clarke: "To us the genus represents the structural unit, a point of departure; species, diverse expressions of the generic type; families, associations of genera representing the offspring of a common parentage." . . . . "A classification is a broken and punctuated expression of organic affinities and interrelations necessary to an easy treatment of any group of organisms, capable of expressing many truths in regard to the development of a race, but even in its most perfect state an index and a confession of faulty knowledge."[1]

A. C.

EXPLANATION OF PLATE V.

Letters A. Atremata; N. Neotremata; P. Protremata; T. Telotremata; = Orders.

p. paterina stage; *o.* obolelloid; *l.* linguloid; *a. l.* adolescent linguloid (Fig. 7). S. Surviving genera.

FIG. 1 *a, b, c.* A. *Paterina Labradorica*, var. *Swantonensis*, Walcott. Lower Cambrian, Vermont.

FIG. 2. A. *Obolella crassa*, Hall (after Hall).

FIG. 3. A. *Obolus* (*Botsfordia*) *pulchra*. × 3 (after Mathew). St. John Group, N. B.

FIG. 4. A. *Lingulella Dawsoni*, Mathew. × 3. St. John Group, N. B.

FIG. 5. A. *Lingula lamellata*, Hall (after Hall). Niagara Group, N. Y.

FIG. 6. A. *Lingulops Whitfieldi*, Hall (after Hall). × 3. Hudson River Group.

FIG. 7. A. *Lingula ricciniformis*, Hall (after Winchell and Schuchert). Lower Silurian, Minnesota. *p.* protegulum, or paterine stage; *o.* obolelloid; *a. l.* adolescent linguloid growth stage (greatly enlarged).

FIG. 8 *a, b.* A. *Glottidia* (*Lingula*) *pyramidata*, Stimpson (after Brooks). South Carolina Seas. Obolelloid stages of shell growth of the living species.

FIG. 9. T. *Terebratulina septentrionalis*, Couthouy (after Morse). Coast of Maine. Showing linguloid phase of shell growth.

FIG. 10. P. *Kutorgina cingulata*, Billings (after Hall). × 3.

FIG. 11. P. *Orthothetes lens*, White (after Hall). × 3.

FIG. 12. N. *Discinolepis granulata*, Waagen (after Waagen). Cambrian, India.

FIG. 13. N. *Schizambon* (?) *fissus*, Kutorga (after Hall).

FIG. 14. N. *Trematis Ottawensis*, Billings (after Hall). Nat. size.

FIG. 15 *a, b.* N. *Schizobolus truncatus*, Hall sp. (after Hall). × 3. Genessee Slate, N. Y.

FIG. 16 *a, b, c.* N. *Orbiculoidea minuta*, Hall (after Beecher). Three growth stages, showing the change from the paterina stage (*a*) with transverse cardinal margin, to the circular outline of the adult; *a.* paterina; *b.* nealogic; *c.* ephebolic stages.

FIG. 17. N. *Discina striata*, Schumacher. West African Coast.

FIG. 18. N. *Schizocrania filosa*, Hall (after Hall). Hudson River Group.

FIG. 19. N. *Pholidops Cincinnatensis*, Hall (after Hall). × 4. Hudson River Group.

FIG. 20. N. *Crania setifera*, Hall (after Hall). Niagara Group.

[1] Handbook of the Brachiopoda, Part II. 1895. By James Hall and John M. Clarke.

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An * denotes Memoirs published subsequent to the date of dispatch of this paper to the Women's Auxiliary Branch of the World's Congress, held at Chicago, August 24th, 1893.

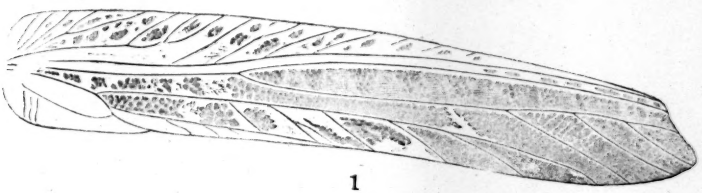
III.—The Miocene Insect-fauna of Œningen, Baden.

By Samuel H. Scudder, Cambridge, U.S.A.

(PLATE VI.)

THANKS solely to the labours of the late Oswald Heer, the fossil insect-fauna of Œningen is better known than that of any other locality or horizon in the world. But it is by no means so well known as it should be; for although Heer, in his latest enumeration of the specimens seen by him (Urwelt der Schweiz, 2e Aufl. 1879, p. 383), repeats precisely the same figures he has already given in 1861 (Recherches sur le climat du pays tert., p. 197), indicating in an interval of eighteen years no addition to his material (over 5000 specimens), his repeated additions to the number of species from that locality show that he had not fully worked over what he had. Indeed, thirty years ago, I arranged for exhibition in the Museum of Comparative Zoology at Cambridge a collection of nearly one hundred and fifty named species secured by Prof. Louis Agassiz from Heer, of which more than forty still remain undescribed; there are also a considerable number of merely nominal species enumerated by Heer in his Urwelt der Schweiz and elsewhere, duly catalogued by me in my Index to Fossil Insects (Bull. U. S. Geol. Surv. No. 71), but as yet neither described nor figured. In addition to this it may be noted that in the enumeration referred to above Heer mentions 543 species of beetles, while less than 270 nominal species have yet been published from Œningen, and only seven species from the Swiss Miocene, included in the enumeration.

Recently, by the request of Mr. R. D. Lacoe, of Pittston, Penn.,



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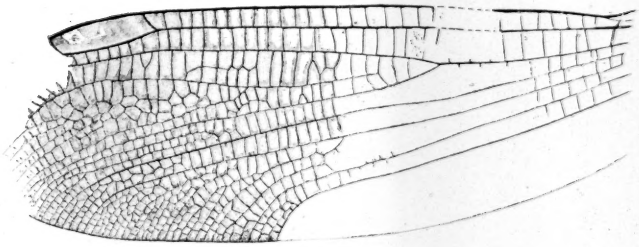

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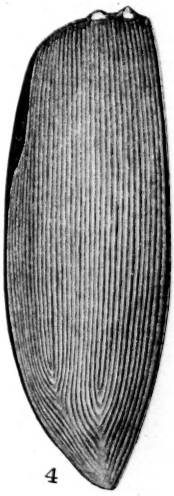

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5

J. Henry Blake del.

Fossil Insects from Œningen.

I have examined with some care his large collection of fossil insects from Œningen, larger, perhaps, than any outside of Zurich, for it consists of about 3500 specimens, of which fully one-half may be made use of to advantage. From the better specimens I have separated over four hundred species; and as not a few unpublished forms occur among them, I have thought that a summary account of the collection, with a notice of a very few of the forms, might prove interesting to others, especially as I can add some statements regarding species determined and named by Heer, but not yet published, certain species named by him being accessible, as already stated, in the Museum at Cambridge, and a few in my own small collection. Altogether I have examined about 4000 specimens.

The 428 species which I have separated in Mr. Lacoe's collection are divided among the orders as shown in the following table, in which they are placed beside Heer's enumeration of the species which had passed through his hands, and each reduced to percentages for better comparison:—

	In Heer's Collection.		In Lacoe's Collection.	
	No. of Species.	Percentage of whole.	No. of Species.	Percentage of whole.
Orthoptera	20	+ 2	8	− 2
Neuroptera	29	+ 3	13	+ 3
Hemiptera	136	− 16	57	+ 13
Coleoptera	543	− 62	294	− 69
Diptera	64	+ 7	17	− 4
Lepidoptera	3	− 1	0	0
Hymenoptera	81	+ 9	39	+ 9
Total	876	100	428	100

From this table it appears that the relative number of species in the different orders is almost strictly identical in the two enumerations, and enables one to assert with much assurance that in number of species the Coleoptera of Œningen are vastly preponderant, including about two-thirds of all; and that first the Hemiptera, and next the Hymenoptera follow, the Diptera lagging somewhat behind, with a feeble and not very differing representation of Neuroptera and Orthoptera.

Among the Orthoptera by far the most abundant insect is Heer's *Decticus speciosus*, of which, including reverses, I have seen sixty-four specimens, all tegmina, and in one case accompanied by a part of the hind wings. There is one specimen (No. 6861) which may be another species, very much smaller than the others, which vary from 43 to 60 mm. in length, while this is only 30 mm. long., and yet is a female. Females appear to be more frequently preserved than males, for of such as can be distinguished, the basal area being sufficiently preserved, there are 26 males to 15 females. It is not very well figured by Heer in his woodcut, since the pale flecks are not round, or only occasionally so, being rather short oblique bars;

the specimen he has figured also does not show the costal edge, or rather represents the costal area as exceedingly narrow, and thus gives a false impression. I have, therefore, refigured it here (Pl. VI. Fig. 1). The insect in reality belongs to *Drymadusa*, Stein, and is distantly allied to the living European *D. spectabilis*, Stein; but it differs from it in having straighter and slenderer tegmina, and considerably narrower costal area; all the other interspaces, too, are narrower, and while the neuration is practically identical, there are no stout distant cross-veins between the principal nervures such as are present in the living species, and especially in its female, though occasionally a single feeble one, or possibly two, may appear between the main branch of the posterior radial and the ulnar at their nearest approximation, or at the base of the former; as in *D. spectabilis*, the main branch of the posterior radial arises about opposite the extremity of the mediastinal vein.

If I have rightly determined as *Phaneroptera vetusta*, Heer, a number of specimens from Œningen, then that insect belongs to an undescribed extinct type of Phaneropteridæ, apparently allied to *Arythæa*, Stål., and in which the tegmina are very slender and the main branch of the anterior radial (Brunner's nomenclature) is united near its base to the ulnar vein by an oblique and strong cross-vein; this main branch has three well separated branchlets, not clustered at the tip; if the ulnar has any branches, they are exceedingly slight and have but a narrow area to cross. The anterior radial runs in the apical half of the tegmina midway between the mediastinal (which extends far towards the apex) and its own main branch, and in the upper of the two interspaces thus formed the cross-veins are tolerably numerous and oblique (transverse apically), in the lower similarly numerous and transverse.

No Orthoptera belonging to the true Acrididæ have heretofore been recognized at Œningen; but in Mr. Lacoe's collection is a single specimen (No. 6844) and its reverse of the larger and more important part of one of the tegmina of an insect, showing pretty clearly by its form and neuration that it belongs to *Acridium* in its restricted sense. It may be called *Acridium Œningense* (Pl. VI. Fig. 2). The posterior branch of the discoidal vein has five branches with an intercalary between each pair; the median vein forks in the usual manner, presumably in the middle of the wing, which, if so, is then about 51 mm. in length, indicating an insect about the size of *A. tartaricum*, Linn.; the ulnar vein forks a little before the median, its upper branch arching towards, but in no way connected with it; what is remarkable, and found in no other *Acridium* or *Schistocerca* I have noticed, is that the lower branch of the upper fork is itself divided soon after it origin. The close reticulation of the base of the tegmina extends to the middle of the wing, beyond which the cells are quadrangular. There is some indication that the tegmina were broadly mottled or clouded, but this is not certain. The length of the fragment is nearly 36 mm., and its breadth 8 mm.

The Neuroptera of the collection show at least four undescribed

species of *Termitina*, of which one belongs to *Calotermes*, a genus not before recognized at Œningen, while the others appear to belong to a new type of white ants with closely crowded, branching, sub-longitudinal veins in the anal area. There are also several species of what is apparently a new generic type of Phryganidæ.

Two or three specimens of a Dragon Fly's wing occur (Pl. VI. Fig. 3) which I refer with little doubt to *Agrion iris*, Heer. They show that I was correct in referring this species to *Lestes* (Tert. Ins. p. 127), but an examination of these specimens shows that it cannot be placed in any of the subgenera established by de Selys, in his "Synopsis des Agrionines," 1862, but is strikingly different from any of them, though apparently nearest *Megalestes*. The group, which may be called *Stenolestes* (στενός, Lestes) would be characterized by the following features, which from the fragments preserved must of necessity embrace only such as can be drawn from the portion of the wing beyond and including the nodus: Nodal sector arising from the principal at about eight[1] cells beyond the nodus; the intercalary ultranodal sector not at all angulate, but its general course broadly sinuous; all the other sectors straight, except when curved next the margin; several intercalary sectors between the nodal and the subnodal, many between the median and the sector brevis and between the ultranodal and the nodal, but excepting at extreme margin, only a single one between the subnodal and the median sectors. There are about thirty postcubitals and the pterostigma is elongate, about five times as long as broad, and surmounts eight cellules, an exceptionally large number for a *Lestes*.

Among the Hemiptera are several galls easily referable to Heer's *Pemphigus bursifex*, but also two or three others which probably or pretty certainly represent the work of other plant lice. There are several new Jassidæ and Lygæidæ. In the Coreidæ Heer has recognized (Mus. Comp. Zool.) another species of *Syromastes* and another *Alydus*, and there are six or eight new species of this family in Mr. Lacoe's collection. The Pentatomidæ are the most numerous group, and here again Heer has recognized an additional species each of *Cydnopsis* and of *Pentatoma*, while in Mr. Lacoe's collection there are eleven species of *Cydnopsis*, of which five are new, and there is an additional species perhaps referable to *Eurydema*.

The Coleoptera are too numerous to mention in much detail, but of genera among Curculionidæ not before noted at Œningen I have recognized *Balaninus*, *Baris*? *Cryptorhynchus*, *Tychius*, *Bagous*, *Tanysphyrus*, *Rhinocyllus*, *Hylobius*, and *Plinthus*; while Heer recognizes *Cionus*, *Phytonomus*, *Hipporhinus*, and *Hypera*, besides half a dozen additional species of *Cleonus* and two each of *Larinus* and *Sitona*; I have also referred several species each to *Hipporhinus* and *Sitona*, and find new species of *Phytonomus* and *Apion*. Among the Otiorhynchidæ I am inclined to refer several species to *Otiorhynchus* and one to *Tanymecus*, while others appear to fall in the neighbourhood of *Aphrastus*, *Artipus*, *Ophryastes*, *Liparus*, and *Epicærus*. Heer recognizes two additional species of *Lytta*

[1] It is at the most from three to five cells beyond the nodus in all modern types.

among the Meloidæ, and I have seen others, while one of his appears to be identical with his *Prionus spectabilis*; all these are mainly represented by elytra only. Among the Chrysomelidæ, Heer recognizes a new *Galeruca* (of which there are seventy specimens in Mr. Lacoe's collection) and a new *Chrysomela* and *Oreina*; other new species before me seem to be referable mostly to genera already known from Œningen. Heer names a new *Prionus* only in the Cerambycidæ; but in Mr. Lacoe's collection are a number of striking new forms which appear to fall in genera allied to *Agapanthia, Desmocerus, Tylonotus,* and *Callidium.* There is little that is new among the Scarabæidæ: but Heer names a new *Melolonthites,* and in Mr. Lacoe's collection is a new *Geotrupes* and something near *Trichius.* Ptinidæ have not heretofore been recognized at Œningen, but I have seen what is probably an *Anobium.* In the Lampyridæ, Heer names an additional *Lampyris,* and Mr. Lacoe's collection contains three species in whole or in part referable to *Telephorus.* In the Buprestidæ, Heer recognizes *Agrilus* and names new species of *Perotis, Capnodis,* and *Buprestites,* while in Mr. Lacoe's collection are undescribed species of *Agrilus, Acmæodera,* and *Ancylocheira*? Heer sent Agassiz three species of *Elater* and five different species, unnamed, which he referred to *Elaterites.* Mr. Lacoe possesses numerous examples of two of these species of *Elater* besides two others, and of other Elateridæ a new *Cardiophorus,* two new species of *Ampedus*? and two referred with doubt to *Eucnemis.* Heer names two new species each of *Nitidula* and *Hister,* and one of *Coccinella,* while Mr. Lacoe has two other new species of *Coccinella* and two falling somewhere near *Rhizobius.* None of the described Staphylinidæ are in Mr. Lacoe's collection; but the four species which it contains appear to fall in, or in the vicinity of, *Megarthus, Acidota, Oxyporus,* and *Staphylinus.* In the Hydrophilidæ, Heer names a new *Hydrobius*; and a new species of *Hydrophilus* allied to *H. spectabilis,* Heer, but slenderer and smaller, occurs in Mr. Lacoe's collection. Finally, in the Carabidæ, Heer names two new species of *Harpalus* and an *Elaphrus,* a genus not before recognized at Œningen; while in Mr. Lacoe's collection I find three other new species apparently referable to *Harpalus,* two new species of *Pterostichus,* one which may be a new *Amara,* and others which appear to fall in or near *Badister, Diplochila,* and *Bembidium,* besides a remarkable new *Calosoma.*

Six species of *Calosoma* are already known from Œningen. The seventh, to which it seems well to call attention, is represented only by elytra (Pl. VI. Fig. 4), as is the case with most of the species already figured; but it is readily distinguished from all of them by the double number of striæ, there being thirty-two instead of sixteen, which is the most other fossil *Calosomæ* have. The striæ are more delicate than in the other species, but perfectly sharp, and are delicately punctate throughout, the puncta in one stria about as distant as those of neighbouring striæ. There are no large impressed puncta (a character common to two other species from Œningen), and the transverse striation of the interstices, peculiar to *Calosoma,*

is very faint. The twelfth stria, counting from the sutural edge, terminates abruptly a little beyond the middle of the distal half of the elytra, and the four adjoining striæ on one side unite with their mates of the other side, by curving around its extremity in wider and wider curves, while the sixth and seventh unite in a similar but much more angular fashion with the eighteenth and seventeenth. In like manner the twenty-fourth stria from the sutural margin terminates almost exactly at the middle of the distal half of the elytra, and the twenty-second and twenty-third striæ unite with the twenty-sixth and the twenty-fifth around its extremity. One elytron (that figured No. 4873) is 16 mm. long, and 5·25 mm. broad; a second (No. 4878) less perfect one is a trifle larger. The form of elytron is almost precisely that of *C. nauckianum*, Heer, from Œningen, but has a slightly more produced apex. The species may be called *Calosoma Heeri*.

Among the Diptera, a single specimen occurs of a new generic type of Tabanidæ, allied to *Tabanus*, in which the upper sinuate branch of the third longitudinal vein is widely forked at the tip, and the lower branch, curving downward, terminates not on the border of the wing but on the upper branch of the fourth longitudinal vein just before its apex (No. 7056). There are two species of *Tipula*, at least one of them a *Tipula* in the narrowest sense. The Bibionidæ consist of three species of *Plecia* and two of *Penthetria*, none of which can be referred to described species.

There is a single specimen (No. 6893) of a minute fly, unusually well preserved, indicating a new genus of Mycetophilidæ, which may be called *Necromyza* (νεκρός, μύζω). The marginal vein of the wing reaches the end of the subcostal; the auxiliary vein impinges on the subcostal just beyond the origin of the cubitus, which arises at about two-fifths the distance from the base to the apex of the wing; the brachial cross-vein is at the middle of the wing; the second posterior cell extends back to the humeral cell itself, and the fourth posterior cell is even longer, reaching as far as the middle of the humeral cell. These characters easily distinguish it from any Mycetophilidæ known to me, the most nearly allied being, perhaps, *Brachypeza*. The hind thighs are stout, longer than the thorax; the hind tibiæ, which are twice as stout at apex as at base, are armed with a pair of stout apical spines half as long as themselves, while the hind tarsi are half as long again as the tibiæ. The insect is 3 mm. long. The wings are faintly fuliginous, and the antennæ, chancing to converge in front of the head, give an appearance of a long beak. It may be called *Necromyza pedata* (Pl. VI. Fig. 5).

The only other Diptera of interest are three species of Cecidomyian galls, one probably to be referred to *Cecidomyia Bremii*, Heer.

Among the Hymenoptera, the ants comprise the bulk of the material, and there seem to be several new species of *Formica* and *Myrmica*, besides some others of uncertain position, but certainly new, and still others falling near *Sima* and *Prionomyrmex*. There is a species of *Sphex*, a genus already recognized by Schöberlin, but not by Heer, and an insect which may possibly be *Bombus*

grandævus, Heer, but which belongs to a new genus of Apidæ, in which the neuration more closely resembles that of *Eucera*.

EXPLANATION OF PLATE VI.

FIG. 1. *Drymadusa speciosa*, Heer, sp.; male fore-wing $\frac{2}{1}$.
FIG. 2. *Acridium Œningense*, sp. nov.; fore-wing $\frac{2}{1}$.
FIG. 3. *Stenolestes iris*, Heer, sp.; outer portion of fore-wing $\frac{3}{1}$.
FIG. 4. *Calosoma Heeri*, sp. nov.; elytron $\frac{1}{1}$.
FIG. 5. *Necromyza pedata*, sp. nov.; $\frac{1}{1}\frac{2}{2}$.

IV.—An Interesting Contact-Rock, with Notes on Contact-Metamorphism.

By W. Maynard Hutchings, F.G.S.

FOR a considerable time past I have been engaged, in collaboration with Mr. E. J. Garwood, in an investigation of the rocks in contact with the Whin Sill. The results of our joint work, geological, petrographical, and chemical, will be published in detail in due course. In the meantime there are some special observations, made on some of the rocks in question, which have more or less bearing on some of the points dealt with in a paper I contributed to the Geological Magazine last year (Geol. Mag. 1894, pp. 36 and 64).

These observations having been made since that paper was printed, I have thought that it may be worth while to give an account of some of them, more especially as regards an interesting bed of altered shale which occurs at Falcon Clints. It is at this locality that the contact-action of the Whin Sill is very strikingly developed, there being an exposure showing fine garnet-limestones and other altered rocks. The bed in question is 75 feet below the contact, from which it is separated by a series of layers of limestones, sandstones, and shales, all altered. It is 8 feet thick, and rests on the basement conglomerate of the Lower Carboniferous.

It is for the most part a darkish gray, compact rock, with no remaining fissility. Its appearance is in many respects like that of some felsites. Its most striking macroscopic characteristic is that it contains large numbers of spherical, and approximately spherical bodies, like peas, and of various sizes up to rather over half an inch in diameter. These nodules are of a darker colour than the rock. They are not at all evenly dispersed in it, being at some places comparatively rare and scattered, while at others they are closely packed, and in some cases touch one another. At some parts of the rock they can be easily taken out unbroken, leaving perfect hollows where they have been; at others they are not in this loose condition, and can only be got out in bits by smashing the specimen. This difference is due to a slight weathering-action having, in some of them, caused the formation of a less coherent skin between the nodule and the containing rock.

Microscopic examination shows that this bed is not quite uniform in its nature throughout, and chemical tests confirm this. Thicker beds of shale or clay in the Carboniferous are nearly all found to vary in nature, as successive layers contain varying proportions of quartz and of fine clay-material, so that their chemical com-

position may differ a good deal *quantitatively*; and it is partly to such initial variations, and partly to consequent differences in the metamorphic action of the igneous rock, that we must ascribe the differences that we find in the microscopic examination of slides from several points in this bed, which is macroscopically a fairly uniform mass.

To give an idea of this interesting rock it will be best to describe separately two or three typical sections, whose nature will give a good general idea of the various points to be observed at this exposure of the bed in question.

Thus, from numerous hand-specimens collected near together, several slides have been made in which some of the spots have been included; in this case spots which are firmly incorporated in the rock and cannot be detached.

In ordinary light a very thin section shows the main portion of the rock to be composed of a uniform gray mass, in which are bedded abundant grains of clastic quartz of an average size of about $\frac{1}{80}$ inch, but ranging up to as much as $\frac{1}{30}$ inch in diameter. The gray ground-mass shows a vast number of rutile-crystals of very small size. They are not in the form of the "clay-slate needles," but in the relatively short and blunt form, with definite terminal developments, so usual in altered rocks. There are also the numerous small zircons, and the small hemihedral crystals of tourmaline, so characteristic of clays, shales, and slates. In all respects this rock corresponds to an altered moderately quartzy clay or shale, such as can be examined in any number of instances in the Carboniferous beds.

In polarized light this gray ground-mass shows, however, most interesting developments. Most of it is seen to consist of rounded, irregular, or more or less definitely bounded grains of a mineral, or minerals, lying bedded in and surrounded by a material which is mostly quite isotropic, but at other times shows an indistinct effect of birefractive substances developing within it.

At some places we have the polarizing grains closely packed together, with so little of the surrounding isotropic material that they amount to a true interlocking mosaic; at others they are very much more separated, and we have quite large spaces of the surrounding material, perfectly isotropic, but containing the swarms of minute rutiles, small flakes of white mica, and a certain amount of indistinct dusty and granular substances diffused in it.

A large portion of the polarizing grains can be proved to be quartz, some of them can be identified as felspar, though this is more difficult, and a good proportion cannot be made to give any definite optic tests at all. The grains are not yet water-clear, nor yet so sharply defined as those of a perfectly developed contact-mosaic; there is a certain amount of dimness in them, which is accentuated also by their envelopment in isotropic base full of microlites. It is, however, certain that we have here a production, due to the metamorphism of the shale, of quartz with more or less of felspar. All these grains are in every way perfectly and sharply

distinguished from the original clastic grains of the shale; not one could by any possibility be mistaken for original material, even if only for the reason that they are full of minute rutiles and other material from which the clastic grains are quite free.

Here and there white mica is developed in larger flakes, lying in all directions, and, as before remarked, there is a good deal of the mineral in minute flakelets. But, on the whole, mica is a subordinate mineral in these special slides.

The clastic quartz-grains are a very interesting study. They are all more or less corroded and altered round their outer portions. The angular outlines of the original grains are in nearly all cases quite preserved, but the outer portions are no longer quartz. They are seen to be attacked and altered by the material of the isotropic base, and the altered rim so produced contains a large amount of white mica. In many grains this mica is seen to penetrate well into the quartz in little bays and gulfs, or as isolated streaks. It is largely in the form of sheaves and radiating groups of flakes.

In some cases the corrosion and alteration of the quartz-grain has taken an even more striking form. Thus, *e.g.*, one grain with an average diameter of $\frac{1}{45}$ inch is altered to about half its extent. The inner portion is still pure unaltered quartz, with its cavities and bubbles; the outer part is faint yellowish in colour, and quite sharply marked off in ordinary light from the original mineral. With lowered condenser it shows a granular and fibrous structure; in polarized light it is seen to consist of clear transparent isotropic matter, and to contain numerous sheaves and spherulitic bundles of polarizing fibres and needles, which can be optically identified as felspar. The outer boundaries of the original grain are quite sharply marked off against the surrounding mass of hard mosaic and isotropic matter.

In other corroded quartz-grains nests of anthrophyllite have formed, as clusters of prismatic needles; or we have beautiful little deposits of andalusite crystals in elongated prismatic form, with the dichroism unusually well shown.

Turning now to the nodules which are cut in these sections, we find points of great interest, which assist us in interpreting the nature of the rock and the processes by which it has been altered. The nodules are sharply defined, and are darker at the edges than towards the centres. This darkness is due to concentration of pigment, and also to the presence of some ferruginous colouring in parts. In these nodules are large patches of perfectly clear, transparent, almost colourless, and quite isotropic matter, containing no rutiles or other enclosures. With high powers and with suitable illumination, it may be seen that these patches are not quite structureless. There is a minute granulation discernible, and in some of them it passes to a fibrous condition. Other patches of similar material contain large bundles and sheaves and spherulitic aggregates of felspar-needles with a little quartz.[1] And inter-

[1] It used to be considered that in sheaves and spherulites of this description all *negative* fibres were felspar and all *positive* fibres were quartz, but it has been

mediate stages may be seen in which the needles of felspar and quartz are beginning to form in the isotropic matter, and so on down to a stage where the patches just begin to pass from the isotropic state into a development in which they commence to show a faint and speckly polarization.

In some of the nodules large amounts of anthrophyllite needles have formed in the patches, and a little andalusite is also seen. These fields of isotropic matter, and the new formations of minerals, are seen in these special slides, mainly at the outer portions of the nodules, and at these parts there are none, or very few, of the original clastic quartz-grains, while such as are there are much corroded away, and often represented only by small residues.

In the inner portions the clastic grains are as abundant and as regularly diffused as in the main mass of the rock, while the new formations are much less, or are absent, except that a little isotropic matter lies in among and around the grains, and here and there a little new mosaic is formed.

Full study of these sections gives the impression that we are here looking at a very interesting and instructive stage of the metamorphism of a shale. The finer-grained material has been completely affected by the re-solution of a large part of its original constituents, and out of the matter so formed a mosaic of quartz with felspar is seen in process of crystallizing. The process was brought to a close before such re-crystallization was complete, and so we have left for our observation a large proportion of the residual substance, which we may regard as representing the indefinite product of solution, or of aqueous fusion, of some of the original constituents, which we have such good reason to conclude takes place in the processes of contact-metamorphism.

In the larger quartz-grains we see that this process of solution was attacking them to a considerable degree, and had it continued, would have completely dissolved them away. That we can here see all this in progress, as it were, is due to the fact that we are dealing with the effects of only a moderate bulk of igneous rock, and to other favourable circumstances. If, for instance, the metamorphism were due to a large mass of granite (or to a similarly large mass of dolerite), the earlier conditions which caused the solution (or aqueous fusion) of the constituents would have lasted long enough to destroy the clastic quartz-grains to a far greater extent, or entirely; and the conditions during which the re-crystallization went on would have also lasted longer, and we should have had a completed "contact-mosaic" with either no residual "base" or only a small amount of it, and this not, or only to a small extent, isotropic, such as we may see in the aureoles round some granites.

In the nodules, as above described, we have the same process

demonstrated that this is not necessarily so, as felspar fibres may also be positive, though it is more rare. So that though negative fibres are felspar only, positive fibres may be either felspar or quartz, and the relative degree of bi-refraction must assist in distinguishing as far as possible. (See full *resumé* of this subject in Zirkel's Petrographie, vol. i. 1893, pp. 474 and 476.)

going on, but under special modifications which are not readily explicable. The solution of original materials has taken place very completely at the outer parts of the nodules, so much so that here even quartz-grains have disappeared and we have areas wholly made up of the product of the solution. Here also we see a gradual and unmistakable crystallizing out of felspar and quartz in this material, in an even more striking manner than in the main mass of the rock, because we can here more distinctly trace the passage of this isotropic base into an aggregate of different minerals.

It may be noted that the formation in these nodules, and elsewhere in the rock, of isolated patches of anthrophyllite and andalusite, tends to the conclusion that the inter-action of the components of the shale was not limited to such very short distances as have been inferred by observers in other cases (*see* Harker and Marr, Quart. Journ. Geol. Soc., vol. xlix. p. 368), but that a more considerable amount of interchange and transfer of materials has taken place. A similar opinion was expressed by Miss Gardiner in respect of contact-rocks at New Galloway (*see* Quart. Journ. Geol. Soc., vol. xlvi. p. 579). The analysis of a hand-specimen from which some of the sections described above were cut gives—

Silica	60·15 per cent.
Alumina	25·43 ,, ,,
Ferric oxide	3·95[1] ,, ,,
Lime	0·45 ,, ,,
Magnesia	trace ,, ,,
Potash	1·25 ,, ,,
Soda	2·01 ,, ,,
Water	7·20 ,, ,,
	100·44

We can now consider other series of slides and see other phases of the same processes. As regards the main mass of the rock, we have variations in the relative amounts of the components, and of their present condition. At some parts there is much more mica and very little of the mosaic of good-sized grains of quartz and felspar forming, with little or none of the isotropic matter. The amount of clastic quartz, and the size of the grains, varies also, and so does the degree to which they are attacked and corroded. Other specimens may be obtained of which slides show that they consist in the main of a fine-grained aggregate of quartz and felspar, passing down into a quite cryptocrystalline felsitic-looking mixture, and opening up, on the other hand, here and there into numerous clear and glassy patches, which in polarized light are seen to consist wholly of groups of well-twinned plagioclase, which can be identified as albite in many individuals, whilst the extinctions of some others point to the probable presence of a species allied to oligoclase.

These very fine-grained mixtures of quartz and felspar (mainly albite) are a frequent product of the alteration of shales or slates by dolerites (diabase), and are fully described by authorities writing

[1] A part is present as ferrous oxide—hence excess in the analysis.

on such alterations in the Harz and elsewhere. They are also seen at other parts of the Whin Sill contacts, besides the locality with which we are now dealing. They are known as *adinoles*, and will be so spoken of in what follows. A large part of the typical adinoles shows the mixture of quartz and felspar in a quite unresolvable, cryptocrystalline condition, and its true nature, apart from chemical evidence, can only be ascertained through the circumstance that nearly all occurrences of it open up here and there, in perfect continuity, into patches of so much coarser grain that the components can be clearly made out.

It is usual to designate as adinole more specially the contact-rock close to the intruded igneous mass, and to associate with the name also an increased percentage of silica, which it can be shown in many cases to possess. But there are many reasons, upon which I need not enter here, why these restrictions should not be placed upon the name, and in favour of the rationality, in adopting the term, of applying it to all the alteration-products of shales, slates, etc., by basic intrusions, in which a fine-grained mixture of quartz and plagioclase has resulted.

As regards the nodules, they vary mineralogically in every degree of *quantitative* composition, but seem to be all due to the different degrees of the same processes indicated above. Many of them show nothing beyond an aggregation of pigment, and a quite narrow ring of material differing from the rock outside and inside their areas. These occur in parts of the rock which are not so much affected by re-solution of materials. The quartz-grains are very little attacked in these cases, and are the same inside as outside the ring. Such nodules are really to be described as mere shells of a special alteration-product, enclosing areas of the less altered or differently affected material among which they have been formed. In other nodules, again, the shell widens and can be better studied, and it is seen that instead of fields of isotropic matter with sheaves and spherulites of felspar and quartz, we often have the adinole-material varying from cryptocrystalline to microcrystalline. In such bands the clastic quartz is in all stages of disappearance. Sometimes it is quite gone, but more usually corroded grains may still be seen, the final stage being that only small blebs and speckles of it remain to show where the larger grains once were. Where the shell is of any considerable width it is very often distinctly banded in concentric layers of more or less varying colour, and it frequently varies also in the degree of crystalline development in these layers. There are also frequently concentric cracks in these shells, which appear to indicate some strain during final cooling of the rock, or more probably during the final consolidation and crystallization of the material forming the shells.

These shells of more considerable width still surround and enclose, in most cases, a kernel of the altered rock, similar to what exists outside, but there are also cases in which the entire nodule consists of this adinole material, and we have then approximately spherical bodies of more or less banded substance, yellow to brownish in

colour, with no remains of the quartz-grains of the rock except the little residual blebs and grains, and streaks.

Where such largely or fully-developed nodules of adinole are seen we have also a formation of the same material in the main mass of the rock, among the clastic quartz-grains; but the action in these nodules has always been, as it were, intensified. We do not see in the main mass any such areas of complete dissolving of the quartz, and complete development of adinole, comparable to those of some of the large nodules.

It may be mentioned that in addition to this exposure at Falcon Clints, there is another occurrence of nodules known in the contacts of the Whin Sill. It is seen exposed at Rowntree Beck, and is here again in a bed of altered shale, 24 feet below the junction. They are of larger size than those described, having longest diameters of as much as 2 inches, and are more flattened in shape. One such large nodule, studied in thin sections, shows that the outer portion is again composed mainly of adinole, while the inner part is a mosaic of quartz, perfectly "regenerated," the grains interlocking and containing abundance of the enclosures of little rounded fused-looking globules, so characteristic in typical contact-mosaics. Dispersed through the nodule is a large amount of anthrophyllite, and there is also a good deal of chlorite (delessite) which has resulted from its decomposition.

These large nodules differ in some respects of detail from the former examples; but there can be no doubt that they owe their formation to the same processes and respresent the drawing together and concentric deposition of a substance formed in the shale during contact-metamorphism, the action of the substance having been also intensified and more highly developed owing to such concentration.

In my former paper on contact-action, I spoke of a material which can be seen in among the minerals of some altered slates at granite-contacts. In its most typical form of occurrence it shows a characteristic granular structure in ordinary light, and with crossed nicols it shows either a minutely speckly polarization, or stages of the development of this into white mica and other minerals. I pointed out that this material is perfectly *new*, bearing no relationship to anything which existed in the unaltered slates or shales, and that its appearance is so very characteristic that once remarked and studied it can never be overlooked. My suggestion was that this material also represents in these rocks the residues of the dense solutions, or aqueous fusions, of some of the constituents, such solutions having acted as solvents and transformers of other components not originally dissolved.

This substance, with all its appearances and characteristics as described, is more or less present in many of the altered shales near the Whin Sill. It is seen in varying amount in the rock I have been describing, though here its development is not very pronounced, the isotropic matter being in much greater abundance. It always bears the same relationship to the other minerals as it does at granite-contacts.

Since writing the former paper I have examined specimens of it on a much better scale than any I had then seen. Thus there are occurrences of shale at contact with, or enclosed in the Whin Sill mass, which have been left altered mainly, and in one case almost wholly, to this condition. One such rock gives sections which are made up entirely of a ground-mass of this fine speckly material, not far removed from an isotropic condition, with a good amount of white mica and a little dark mica crystallizing out of it in radial bunches and fan-shaped aggregates. Not a vestige of anything of the original shale has remained, except the ever present zircons and the abundant re-crystallized rutiles. This has been a shale rather unusually rich in alkalies (over 7 per cent.), and very free from quartz. It has been extra amenable to solution-action, and it is not possible to study thin sections of it in its present condition and doubt that very nearly all its ingredients had passed into some sort of solution, and that the indefinite and amorphous product was not very far advanced in a process of re-crystallization when fall of temperature put a stop to further development.

It is assuredly a circumstance worthy of note, that in the contact-metamorphism of rocks of the same general nature (clays, shales, and slates) by intrusions of granite, and again by intrusions of dolerite, we can find one and the same characteristic substance appearing, and playing one and the same part in its relationship to the formation of certain minerals, this substance being an absolutely *new* product never seen in the original rocks, nor seen, so far as I am aware, in anything but this particular class of contact-rocks.

Finally, to return to the special bed of rock at Falcon Clints, we may look again at the analysis. It is not intended here to enter into any detailed consideration of the interesting chemical questions involved in the alteration of shales, etc., by *basic* rocks, which questions will be more fully gone into at some future time. I may, however, briefly allude to the point as to the increase of soda in such altered rocks. That such increase has frequently taken place is quite beyond question, as I pointed out in my former paper, unless we wish to absolutely reject much very excellent evidence.[1] Many of the altered shales of the Whin Sill contact will also bear testimony to the same effect. It is not possible in this case to compare analyses of any given stratum of the rock at successive stages of approach to the actual contact, because the Whin Sill is intruded parallel to the strike, and the thickness of any

[1] High authorities, in reviewing all the evidence, have had to come to the conclusion that such transfer takes place at basic contacts; as, for example, Zirkel in his detailed consideration of the contact-effects of diabases (Petrographie, vol. ii. 1894), and also Roth (Chemische Geologie, vol. iii. 1893). No geologist has made such a special study of the chemical side of petrology as Roth, and a great amount of the evidence on this particular question is collected and summarized in the volume named. In reviewing this evidence Roth says that, according to it, "there is a decided contrast between the contact-effects of granite, syenite, etc., and those of diabase: in the former case no introduction of material into the altered slates and no chemical differences due to distance from the eruptive rock; whereas in contact with diabase we have introduction of silica and soda into the altered slate, and at the same time chemical difference according to distance from the eruptive rock."

given bed affected is not sufficient to allow of comparisons. Thus, the bed we have specially considered is eight feet thick. Its alteration is as intense at the bottom as it is at the top, and chemical tests also show that no differences occur on which stress could be laid in this connection. And so with the other beds affected. But we know that clays and shales in the Carboniferous beds invariably contain much more potash than soda, say from three to four times as much. This is fully borne out also among the rocks at the Whin Sill. Some of the shales of which I have made analyses show that no chemical change has taken place in them, and in such cases the potash and soda are in the normal proportions,—as near as may be, for instance, as in the analyses published by me of clays from the Coal-measures.

When in these beds we find altered shales or clays with more soda than potash, or even with an approach to equality in these bases, we are quite safe in concluding that this striking alteration in the normal proportions is due to the intruded soda-bearing rock in some way. This is the case with the rock we are now considering; the soda is considerably in excess of the potash. As to how the transfer has taken place in these cases, there seem to be three possible causes to be considered. It may have taken place at the time of the intrusion, by actual passage of igneous magma; it may have been effected after intrusion, and during the subsequent heating and cooling of the sedimentary rocks, by the passage of hot aqueous or vaporous compounds, or both; or, it may be brought about after complete cooling, and long after all "contact-action," by the percolation of water from the igneous rock during weathering.

The first of these conditions may apply, to a limited extent, close to contact. It certainly does not apply to the bed now in question, which is 75 feet from contact, and separated from it by several other alternating beds of shale, limestone, and sandstone. The third condition may frequently apply to a small extent and sometimes to a considerable one. But, in the present special instance (and in others in the same district), microscopic study of the rock precludes the supposition that subsequent percolation has deposited soda-compounds in it. When we have a specimen consisting of a hard, compact, felsite-like mass, which the microscope shows to consist of a mosaic of quartz and felspar, we cannot readily understand how the original rock could be removed, and this deposited, by percolation. And still less can we do so when we have a rock consisting of quartz, felspar, isotropic matter and white mica. It would be different if it were more or less cracked and rotten, and showed zeolites in it, but of this there is no trace.

We must deal with the fact that transfer *does* take place, in spite of the many difficulties in the way of understanding exactly how it is effected; such difficulties as arise when we have to note that in one given section of beds there will be cases in which evidence of transfer is wanting, though beds further from the contact are strong in such evidence. Such difficulties are, at any rate, not greater than, and are indeed analogous to, others which we have to face

in considering some undoubted facts as to contact-metamorphism in general.

So far as concerns the particular case in point, and the conclusions we may draw from it, the question is not in any way affected by the manner of transfer of the soda, nor even by the possible denial of any such transfer at all.

(*To be concluded in our next Number.*)

REVIEWS.

I.—Reported Discovery of an Animal intermediate between Man and the Anthropoid Apes.

Pithecanthropus erectus. Eine menschenähnliche Uebergangsform aus Java. By Eug. Dubois. 4to. pp. 1–39, with two Plates. (Batavia, 1894.)

REPORTS of the discovery of the remains of animals intermediate between Man and the Anthropoid Apes are always to be received with scepticism, since the resemblances between the skeletons of the higher Primates are so considerable that abnormalities, due to disease and other causes, are liable to be regarded as evidence of the existence of intermediate forms. There can be little doubt that this is what has happened in the present instance, portions of an abnormal human skeleton having been made the types of a new genus and species, *Pithecanthropus erectus*, for the reception of which a new family, the Pithecanthropidæ, has been established. The name *Pithecanthropus* was originally employed by Haeckel to denote a hypothetical animal forming a connecting link between man and the higher apes, and it is in this light that the creature, to which the name is now applied, is regarded, where they were found associated with extinct mammalia.

The remains upon which such important conclusions have been based consist of the upper portion of the cranium, a tooth (m. 3), and a left femur, all of which were found near the village of Trinil, on the Bengawan River, Java, and are considered to have belonged to a single individual. The rock from which these bones were obtained is a volcanic ash, a deposit which in a country like Java, subject to frequent volcanic eruptions, must often enclose the remains of men and animals that have been overwhelmed. A somewhat similar case of the discovery of human remains in volcanic rock is recorded by Scrope in his work on the volcanoes of Central France, two skeletons having been dug out of a bed of "tuff" near Le Puy, in the Auvergne district.

The skull, of which the upper and hinder portions are preserved, is dolichocephalic, and measures 18·5 cm. in length. All the sutures are closed, and there are no bony crests for the insertion of muscles. The photographs show that the whole surface is covered with pits and rugosities which might be the result of weathering and *post-mortem* injuries, but have much the appearance of a diseased

condition. The cubic contents of the brain-case are estimated to hav been approximately 1000 cubic centimetres, so that in this respec the fossil would appear to come about midway between the skulls o Man and the Gorilla. This calculation is to a large extent con jectural, since the whole of the lower portion of the brain-case i wanting.

The tooth, which is a third upper molar, is considered by th author to indicate that the jaws, though having to some extent bee reduced, were of the type found in the Gibbons and Chimpanzee but the evidence is quite insufficient to support such conclusion: This specimen is almost certainly human, the last upper molar i man being a somewhat variable structure.

The femur is without doubt human, since it agrees both in size an in all important structural characters with that of a man of mediur height. It is not quite normal, but has on the inner side of th shaft near the upper end a considerable irregular outgrowth of bone which may be, as the author suggests, the result of a wound, or o some pathological condition. The photograph shows that the whol surface of the femur is rough, but, as in the case of the skull, thi may be the result of *post-mortem* changes.

That the remains described are those of a man suffering fron disease which caused the sutures of the skull to close prematurely giving rise to a microcephalous condition, and led to the irregula outgrowths of bone on the femur, is almost certain, and at any rat is an explanation of the facts that must be disposed of before th author's conclusions can be accepted. C. W. A.

II.—Memoir of Sir Andrew Crombie Ramsay. By Sir Archibal Geikie, F.R.S., Director-General of the Geological Survey o Great Britain. 8vo. pp. xi. and 397, with 13 Portraits (London: Macmillan and Co. Price, 12*s.* 6*d.* net.)

THOSE who have read the Lives of Edward Forbes and o Murchison will have looked forward with keen interest t the appearance of this volume, written as it is by one so deft i the art of biography. Although nigh half an ordinary life-tim has passed since the first of these Memoirs was published, ou author comes again before us with the same enthusiasm in hi work, with the same sympathy for his hero; and fitting togethe his materials in the same masterly way, he has given us an admir able portraiture of Ramsay and of many of his associates. Leavin that genial geologist to tell his own personal experiences the autho has enriched the pages with picturesque descriptions, with explana tory notes, and not a few touches of humour.

Ramsay was best known to the scientific public through his lon connection with the Geological Survey, and as Professor of Geology at University College, London, and afterwards at the School o Mines. A master in the broader questions of stratigraphy an physical geology he was a clear exponent of facts, while his origina and often bold theories, expressed both in lectures and in writings

stirred others with enthusiasm and undoubtedly exercised great influence on the progress of geology. Moreover, his lectures to working men formed the nucleus of his famous introduction to geology, "The Physical Geology and Geography of Great Britain."

His early interest in geology, when engaged in business in Glasgow, led Ramsay to undertake an original survey of the Isle of Arran. This work brought him under the favourable notice of Murchison, and led to his receiving an appointment on the newly-established Geological Survey under De la Beche. For forty years he took an active part in the work and administration of the Survey, first as Assistant Geologist, then as Local Director for Great Britain, later on as Director for England and Wales, and finally as Director General for the United Kingdom.

The story of his life is thus in its main incidents a history of the Geological Survey with some record of its progress. Opportunity is also taken by his biographer to relate many interesting facts about the Museum of Practical Geology and the School of Mines, which owed their existence to the energy of De la Beche.

So far as regards the progress of the Geological Survey the volume deals mainly with Ramsay's work and that of his colleagues in Wales. He joined the staff in 1841 in Pembrokeshire, when he was twenty-seven years of age. There the freedom of the life, the active outdoor work, and its boundless interest, combined to render most enjoyable the change from a Glasgow counting-house; and for a long while, "Day after day, as he went out with map and hammer, it seemed to him still holiday work."

The life of a field-geologist is often contemplated with a feeling akin to envy by enthusiasts who, tied to business, are able to give but a few weeks each year to outdoor geological work. They picture the sunny side of survey life, and a great portion of it is sunny. The geologist has, however, to carry on his work day after day, for weeks and months together. He may have a pleasant enough tramp in the morning across hill and dale to the tract he has to examine, but after scrambling about for some six or seven hours, he may have a weary march homewards laden with the stony spoils of the day. Again, in the teeth of an east wind, or when any other wind blows strongly, the time of the geologist is not so happily spent as it might be in a tranquil atmosphere. Sir Archibald Geikie gives an interesting sketch of "Life in the Survey," and remarks that "the mere physical endurance which it often requires is enough to tax the strength of a strong man." Moreover, as he justly adds, "The isolation and loneliness at stations where no congenial society of any kind is to be found, the necessity of frequently moving camp to begin all the domestic experiences and discomforts over again, and the poor pay for which all this drudgery has to be undergone, these and other hardships which may be easily imagined test the scientific enthusiasm of a geologist."

Pleasant it is to know that two of Ramsay's early associates on the Survey are still living—Aveline, who joined the staff in 1840, a year before him, and Selwyn, who was appointed in 1845.

Portraits are given of them, as well as of De la Beche, Logan Bristow, Gibbs (fossil-collector), Oldham, Smyth, Jukes, Forbes Murchison, and Salter. The likeness of Ramsay, excellent as it is represents him at the age of 68, when he had just retired from public life; the face has become somewhat saddened, and we must turn to the portrait given in the Life of Murchison for Ramsay in the prime—a handsome, vigorous man, cheery and buoyant in spirit

For about ten years Ramsay toiled hard in the active work of the Survey, until the mapping of Wales was completed, and he continued to carry on a certain amount of personal surveying until 1854. His time, however, had become more and more occupied with the general direction and supervision of the work of his men and he practically abandoned the task of mapping after having started the Survey in Scotland.

It is astonishing to consider how much field-work he accomplished in the period of fourteen years, for we learn from the list of his publications that he took part in the work of six whole sheets and of thirty-nine quarter-sheets of the map in England and Wales and of one sheet in Scotland. Moreover, he was engaged in constructing a number of horizontal sections across various mountainous parts of the country, and the labour thus involved can scarcely be realized nowadays when contoured maps enable the geologist to plot each section without difficulty. No doubt the field-work was carried on far more briskly in those early days of the Survey than would be possible or right at the present time. More numerous subdivisions in the rocks are now required, and the boundaries can be traced far more accurately than was possible on the old one-inch maps. Those who now start with the maps of the present day, with the help too of the advanced methods of research in petrology and palæontology, may find plenty to do in regions surveyed long ago. They do not, however, have to start with a plain ordnance map, and in a district where the only geological guides were the sketch maps of William Smith, or the small maps of particular areas published in the Transactions of the Geological Society.

The junctions between the great formations had to be determined and their particular boundary-lines traced across an almost unknown country, in some areas complicated by faults and disturbances and by various eruptive rocks. It was a glorious time for those who were keenly interested in such work: and none more so than Ramsay and his associates in Wales—Aveline, Selwyn, and Jukes.

In the "Letters" of J. Beete Jukes we were favoured with many glimpses of life on the Geological Survey; of the arduous work and the determination of the men, and of the pleasant hours of relaxation after the work of the day was done. So also in the memoir of Ramsay, we read of the interesting coach journeys, the sojourns at quiet country inns, and the occasional merry meetings of the surveyors and of Salter, the palæontologist.

On one occasion Ramsay relates that he "went out with Smyth, Jukes, Selwyn, Gibbs, and the dogs, to look at Jukes's ash-beds. We had a goodish day's work on bits of detail. Jukes should have

showed me something larger, but detail seems his forte. He is ever in doubt, even when nearly convinced, about little things, and yet grasps the subject so well notwithstanding, that he produces better work and understands it better than any man on the Survey."

"Next day one of the canine companions of the party, 'Jukes's dog Governor, amused himself by slaying a sheep, which cost his master 7*s.* 6*d.*'"

Ramsay himself, as will be gathered from the foregoing remarks, was somewhat impatient of detail, preferring to deal with broad generalizations. When in the field overlooking the work of his men, he cared not to engross his mind too continuously with geological facts, and his conversation was illumined by his passionate love of poetry and of literature in general. Even Murchison, when in the field with him, was apt "to talk far too much geology." In later years Ramsay appeared to manifest perhaps too little sympathy with the careful, but often very minute work, brought before the Geological Society of London; but revisiting Wales, he writes from Portmadoc (1874): "I am busy revising a deal of country and realizing all the discoveries that have turned up since Selwyn and I were here more than twenty-five years ago."

Changes there must be in methods of work and in the interpretation of phenomena as knowledge increases; changes also come about in our social proceedings. Those who attend the Anniversary Meeting of the Society and the dinner afterwards, will hardly do as Ramsay did in 1848. He says: "We broke up about eleven, and in the long-run Smyth, Reeks, Bristow, and I had some supper. Got home at half-past three."

Of the scientific work achieved by Ramsay we have a good summary in the concluding chapter of this volume: a fitting termination to the record of his career, of his travels abroad as well as in this country, of his eager study of glacial phenomena, and of his bold theory of the origin of certain lake-basins. To learn the history of these and other matters the student will gladly take up this Memoir by Sir Archibald Geikie; and whether or not he has had the privilege of personal acquaintance with Ramsay, the student or the general reader interested in the progress of science, will welcome this memoir of a genial and gifted Geologist.

III.—The Physical Geology and Geography of Great Britain: A Manual of British Geology. By the late Sir Andrew C. Ramsay, LL.D., F.R.S., etc., Director-General of the Geological Survey of the United Kingdom. Sixth Edition. Edited by Horace B. Woodward, F.G.S., of the Geological Survey. 8vo. pp 421, illustrated with a Geological Map printed in colours and 137 woodcuts. (London: Edward Stanford, 1894.) Price 10*s.* 6*d.*

IT is now sixteen years since the fifth edition of Sir Andrew Ramsay's Geology appeared (see Geol. Mag., 1879, p. 277), having gone through five editions in ten years. The last edition

was issued three years before its author retired from the post of Director-General, after which time his literary labours ceased.

The new edition has by careful excisions been reduced from 639 to 422 pages, so as to approach more nearly to the convenient size of the earlier editions of the work. The stratigraphical portion has been reduced by about 61 pages; the Glacial chapters by about 38 pages; the other reductions come under the head of Historical Geology, the Races of Man, etc.

Mr. Horace Woodward, the editor, has bestowed great pains and labour on the new edition; and both the stratigraphical and the palæontological parts have been carefully revised, and the names of fossils corrected.[1] He has very properly kept intact the author's views on Subaerial Denudation, which Ramsay was the first to teach and illustrate.

The strict subdivisions of the subject-matter in each chapter have been more strictly adhered to than in the earlier edition, and without altering the author's style the book has been brought up to date as far as possible.

This manual will still be valued as the work of one of the most able and thoughtful geologists of our time, whose broad views on the stratigraphy and on the physical features of this country due to the structure and character of the rocks composing it, and how they have been affected by denudation, will always be read with pleasure and profit by all students. The book is also provided with an excellent index.

IV.—A Dictionary of Birds. By Alfred Newton, Assisted by Hans Gadow, with Contributions from R. Lydekker, C. S. Roy, and R. W. Schufeldt. In 4 Parts (3 issued). 8vo. pp. 832, numerous Figures in the Text, and 1 Map. (London: Adam and Charles Black, 1893–4.)

THE Third Part of this very useful Dictionary has just been issued, after a rather long interval, and it is to be hoped that the concluding part will soon follow.

Books in dictionary form are extremely handy for reference and commend themselves to everyone, especially if they are as well executed as is the book now under our notice, and there is no doubt that this dictionary will be very serviceable not only to ornithologists but also to all students of Natural History.

A great deal more is contained in these volumes than the title might lead one to expect, for we find in addition to the excellent accounts of birds given under their scientific and popular names, numerous articles dealing with the anatomy, with the habits, distribution, and past and present history of birds. It is in fact a text-book of Ornithology arranged in dictionary form.

Interesting as all these articles are, still some of those already published have a greater claim to the geologist's notice than others; especially those dealing with fossil birds, with the extermination,

[1] One name, *Chara medicaginula*, is, however, still spelt (on p. 203) *Chara medicagulina*.

migration, and geographical distribution of recent birds, and we will hope for a good account of the skeleton in the concluding part.

The special portions devoted to the different groups of fossil birds are contributed by R. Lydekker, and some of these form small but complete monographs of the groups described; but it is a little difficult to comprehend why certain extinct birds were picked out for special description, while a large number of others were lumped together in a general article on fossil birds; thus we find excellent articles on the Moas and the Odontornithes, but *Archæopteryx* and *Æpyornis* are only briefly described under the general title of fossil birds, and the latter is not even mentioned in the alphabetical list. These unaccountable distinctions rather destroy the utility of the book, so far as the general student is concerned.

We see now that the hallux is considered to be present in most if not in all the Moas. Formerly, according to Lydekker (Manual of Palæontology, vol. ii. p. 1226, 1889), it was considered to be present only in the Palapterygidæ and to be absent in the true Dinornithidæ.

The anatomical articles by Dr. Gadow ought to be very useful, and their presence shows that ornithologists now recognize the fact that a bird consists of other structures besides feathers, beak, and claws. That this is thoroughly realized by the highest avian authorities is well seen in the article on the Flycatchers, p. 273, where Prof. Newton, referring to the *Muscarpidæ*, says, "every ornithologist must own that its precise definition is at present almost impossible and must await that truer knowledge which comes of investigating structural characters more deeply seated than any afforded by the epidermis."

The third part (Moa—She), just issued, fully maintains the standard of the earlier parts, and contains many interesting articles, two dealing with fossil birds, viz. Moa and Odontornithes, one on the Moorhen, including an account of *Notornis*, with an excellent figure of the head of that nearly extinct bird; then there are full accounts of the moult, of the muscular, nervous, and reproductive systems; on nidification, and of course short accounts of numerous birds, among which we may notice those on the Ostrich and Rhea, the rapidly disappearing parrot, *Nestor*; of that singular group of birds the Nightjars, with an interesting figure taken from life of the curious form of the pennant-winged Nightjar, showing the way in which this bird carries its enormously enlarged second primary wing-feathers. There is also a good account of the Sandgrouse, whose peculiar irruptions into England have caused so much interest of late years.

The illustrations are very variable and hardly numerous enough. Why should such a little known bird as the Quezal, however beautiful, want an entire page for its portrait, when so many others are unillustrated? Many of the figures are extremely good, especially those of the King-penguin, the Secretary bird, and the Seriema of doubtful systematic position. But for the most part we have to be content with beaks and portions of birds' heads from Swainson.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—January 9th, 1895.—Dr. Henry Woodward, F.R.S., President, in the Chair. The following communications were read:—

1. "The Formation of Oolite." By E. B. Wethered, Esq., F.G.S.

In previous communications the author has described pisolites formed by the growth of *Girvanella*, and some true oolitic granules having a like origin. He has long entertained the opinion that all oolitic granules are of organic origin, but has not, up till now, been in a position to prove this.

He describes the form of the granules, which frequently exhibit a series of concentric layers of calcium carbonate around a nucleus, and also dark striæ and patches, the former placed more or less at right angles to the nucleus. The concentric layers often exhibit an irregularity which the author maintains to be incompatible with their chemical origin, and he considers that each layer represents tubular forms of growth. Again, granules are found made of calcium carbonate occurring in two forms—a vitreous portion representing the organic structural part, and an amorphous portion consisting of ordinary carbonate of lime, which is either infilling or secreted material, possibly both.

In discussing the origin of the crusts around the nuclei, the author treats of the radial structure which is so marked a feature in the crust of oolitic granules. This structure has the appearance of light and dark striæ when seen by reflected light: the light are tubules which have grown at right angles to the nucleus, whilst the dark are secondary formations.

He refers to Rothpletz's description of the oolitic granules of the Great Salt Lake, which are stated to have originated from the growth of lime-secreting algæ, and thinks it possible that the fossil forms are of like origin, though not necessarily due to organisms allied to algæ, and possibly even lower in the scale of life; *Girvanella* was the first type of oolite-forming organism discovered, and it is simply a tubule.

2. "On the Lias Ironstone around Banbury." By Edwin A. Walford, Esq., F.G.S.

The ferruginous limestone of the Middle Lias of the Banbury district occurs practically within a ten-mile circle around Banbury. The stone (the Marlstone of the Geological Survey) is an "oolitic" cyprid-limestone with much molluscan and crinoidal débris and some quartz-grains. The author describes the lithological characters of the rock, and their variations, as traced laterally and vertically, giving a full description of its local development, with detailed account of the sections in the principal exposures. The marlstone of this area is dissimilar from that of Gloucestershire both in appearance and in fossil contents, the Gloucestershire stone being of earlier deposition and representing better the base of the Banbury series, rather than the stratum which is richest in iron. From the blue clays of the *margaritatus*-zone up to the rock-bed itself there is

a slow change of conditions, and the fauna points to slow tranquil sublittoral conditions. The author reserves his views as to how the rock-bed obtained its ferruginous elements.

He gives a description of the palæontology and economic uses of the deposits, and appends analyses of various ironstones from the district, made by the aid of Sir B. Samuelson.

3. "Notes on the Geology and Mineral Resources of Anatolia (Asia Minor)." By W. F. Wilkinson, Esq., F.G.S.

The route traversed from northwards to southwards through the city of Broussa lay through a country composed of sedimentary rocks (largely limestones with some shales and conglomerates). In the mountains metamorphic rocks were met with, and also igneous rocks. The principal igneous rocks noticed are granites and serpentines; in the latter chrome-iron-ore occurs, and is worked.

II.—January 23rd, 1895.—Dr. Henry Woodward, F.R.S., President, in the Chair. The following communications were read:—

1. "Carrock Fell: a Study in the Variation of Igneous Rock-masses. Part II. The Carrock Fell Granophyre. Part III. The Grainsgill Greisen." By Alfred Harker, Esq., M.A., F.G.S.

The augite-granophyre of Carrock Fell is first described in its normal development, special attention being drawn to the various types of micrographic intergrowths which it exhibits. The variation of the rock is next examined, and, in particular, a curious basic modification which occurs near its junction with the gabbro described in a former paper. The granophyre here passes into a coarse type rich in augite, iron-ores, and apatite, its silica-percentage falling to as low as 58. The author attributes this to the acid magma having incorporated in itself portions of the highly basic margin of the gabbro. The latter rock seems to have been fused or dissolved by the magma, with the exception of certain of its more refractory minerals which survive in the modified marginal part of the granophyre.

The latter part of the paper deals with a remarkable quartz-mica-rock found on the north side of the Skiddaw granite. It differs in some respects from the Cornish greisens, and resembles in its mode of occurrence certain pegmatites in the Scottish Highlands. The author considers the rock to have been extruded from the granite in connection with the post-Silurian crust-movements of the district, while its composition has probably been further modified by subsequent chemical changes.

2. "The Geology of the Country around Fishguard (Pembrokeshire)." By F. R. Cowper Reed, Esq., B.A., F.G.S.

The tract of country forming the subject of this communication occupies the northern part of Pembrokeshire, from Newport to Strumble Head. All the beds are of Ordovician age, with the possible exception of those on Dinas Island, and have a general east-to-west strike with a high dip to the north. Arenig Slates occupy the southern part of the district. Typical Llanvirn Beds with the *Placoparia*-fauna occur at Fishguard, and above them the *Didymo-*

graptus Murchisoni-zone of the Lower Llandeilo is found. On this horizon are the first traces of volcanic activity : acid lavas and tuffs are here interbedded with the slates. The Middle Llandeilo is partly faulted out in Goodwick Bay, and near Newport is penetrated by huge intrusive sheets of diabase. The Upper Llandeilo is marked near its base by a thick zone of lava-flows, which are overlain by fossiliferous shales. Hartfell graptolites have been found in the overlying grey and black slates. The lavas and breccias on Strumble Head are held to be on the same horizon as those near Newport.

All the lavas are acid ; some are soda-potash felsites. Nodular, banded, and perlitic structures are sometimes visible. Cryptocrystalline, microlitic, and micropoikilitic types of ground-mass are possessed by these lavas ; the latter type is held to be probably a contact-phenomenon. The intrusive masses consist of diabase, with important tachylitic and variolitic modifications.

3. "On the Mean Radial Variation of the Globe." By J. Logan Lobley, Esq., F.G.S.

The author submits considerations (chiefly derived from the characters of the earlier sediments) which lead him to suppose that crust-folds have not been produced by continuous contraction of the Earth, and that the planetary heat and mean radius of the Earth have been practically invariable during the period which has elapsed since Cambrian times.

III. — February 6th, 1895. — Dr. Henry Woodward, F.R.S., President, in the Chair. The following communications were read :—

1. "On Bones of a Sauropodous Dinosaur from Madagascar." By R. Lydekker, Esq., B.A., F.R.S., V.P.G.S.

The bones described in the paper were collected by Mr. Last to the east of the town of Narunda, on the north-eastern coast of Madagascar. They include vertebræ, limb-bones, and portions of pectoral and pelvic girdles. These bones are described in detail, and the animal which possessed them is referred to the genus *Bothriospondylus*, Owen : a dorsal vertebra, described in the paper, being taken as the type of the new species.

The identification of the Malagasy reptile with a type occurring in the Jurassic rocks of England harmonizes with the reference of some of the strata of the island to the Jurassic period.

2. "On the Physical Conditions of the Mediterranean Basin which have resulted in a Community of some Species of Fresh-water Fishes in the Nile and the Jordan Waters." By Prof. E. Hull, M.A., LL.D., F.R.S., F.G.S.

The author summarizes the evidence in favour of the existence of barriers in post-Miocene times, separating the Mediterranean area into a chain of basins. He brings forward arguments in support of his contention that the waters of the eastern (Levantine) basin became fresh during a period when the area of evaporation was smaller, and the supply of river-water greater, than at present. Into this fresh-water lake the waters of the Nile would flow directly.

He has elsewhere given reasons for believing that the Jordan Valley from Lake Hulch to Arabah was the bed of a lake over 200 miles long, and at least 1300 feet above the present level of the Dead Sea. He suggests that the waters of this lake escaped into the Levantine basin through the plain of Esdraelon. With such physical conditions existing, the fauna of the Levantine basin would have a means of spreading throughout the whole system of waterways connected with it.

In conclusion the author adds some observations on the changes which occurred in the Mediterranean area subsequent to the post-Miocene epoch of earth-movement.

3. "On the Loess and other Superficial Deposits of Shantung (Northern China)." By S. B. J. Skertchly, Esq., and T. W. Kingsmill, Esq., C.E. (Communicated by Sir John Evans, K.C.B., F.R.S., F.G.S.)

The following deposits are described in the order of their antiquity:—

(1) Recent Fluviatile deposits.

(2) Marine sands with *Cardium*, *Ostræa*, and *Bulla*, extending to a height of 200 feet above sea-level, and indicating former submergence to that amount.

(3) Old River-gravels, often resting on loess, and possibly contemporaneous with the marine gravels. They furnish part of the evidence relied on by the authors for supposing the existence at that time of a climate moister than the present one.

(4) Loess.

(5) Basement-gravels having the same relation to the loess that the Upper Greensand bears to the Chalk.

The loess east of the Pamirs is extensively developed over an area of upwards of one million square miles. It is sometimes over 2000 feet thick, and occurs up to several thousand feet above sea-level.

Evidence is brought forward by the authors with the intention of establishing the absolute want of connection between the Chinese loess and the present river-systems, its original stratified condition (as shown by variation of tint and horizontality of layers of concretions), and its subsequent rearrangement to a great extent. The absence of marine shells is discussed, and the suggestion thrown out, with diffidence, that the shells have been destroyed by percolating water.

The authors give their reasons for supposing that the loess is a marine formation, and state that the sea need not have reached to a higher level than 600 feet above the present sea-level, for the Pamir region, where it occurs, 7000 feet above the sea, is an area of special uplift.

They maintain that there are no proofs of the glaciation of Northern and Eastern Asia, so that the Chinese loess can have no connection with an area of glaciation. They state that the zoological, ethnological, historical, and traditionary evidence alike point to the former depression of Asia beneath the sea, and the subsequent desiccation of the land, consequent upon re-elevation.

CORRESPONDENCE.

DR. CROLL'S THEORY OF THE ICE AGE.

SIR,—As Mr. Culverwell's articles in the MAGAZINE and the review of Dr. James Geikie's new edition of "The Great Ice Age" have recalled attention to Dr. Croll's celebrated theory, it may be interesting to your readers to hear the opinion of the great astronomer Adams upon the question. In turning over some old letters only yesterday I came upon one dated 28th February, 1866, which I received from him on the subject, in which, after some remarks upon Herschel's art. 184, of which he says he is "not inclined to think there is much in it," he wrote: "I do not myself believe in the change of eccentricity of the earth's orbit being a cause of climatal changes on the earth. The effect, if any, would depend only on the *square* of the eccentricity; and this always remains so very small, that I believe the effect on the earth's mean temperature would be almost insensible. Depend upon it, geologists who look in this direction for the cause of Glacial epochs are entirely on the wrong tack. It seems to me much more likely that the actual act of emission of heat from the sun is variable, than that the change of eccentricity of the orbit should have any sensible effect."

If this be the case, Croll's theory is reduced to Adhémar's, who, in his Révolutions de la Mer, 2nd edition, 1860, published his view that Glacial epochs were caused by the mere alternate presentation of the north and south poles of the earth to the sun, owing to the precession of the axis; no reference being made by him to changes of eccentricity. It is remarkable that Croll did not know of Adhémar's work when he first published his theory. I had heard two friends talking about it at a meeting of the Geological Society, which led me to buy the book, and finding no allusion to Adhémar in Croll's papers, I drew his attention to it.

In what I have now written I do not wish it to be thought that I am expressing any opinion of my own upon the subject, but I think these matters of ancient history may prove of interest to your readers.

O. FISHER.

HARLSTON, CAMBRIDGE, *7th February*, 1895.

PROFESSOR HULL AND THE CAMBRIAN AGE OF THE CHARNWOOD CLASTICS.

SIR,—I do not think that Professor Hull's letter in last month's GEOLOGICAL MAGAZINE will do much to convince students of the older rocks that the Charnwood clastics are of Cambrian age. He relies chiefly upon the authority of Sedgwick and Jukes. The views of these eminent men on matters coming within their knowledge would undoubtedly carry great weight with the younger generation; but it would be the height of rashness to suggest that they would have continued to adhere to their opinion had they

lived to the present day. Since their time a new chapter of the geological record has been opened. In the Midland Counties large formations have been discovered that bear a much closer relation to the Charnwood rocks than do the Lower Cambrians of North Wales. Professor Hull states that the publication of these results has not led him to alter his opinion. But has he examined the new evidence? Has he studied the Uriconian slates and grits of Shropshire? Does he know the slaty rocks of the Herefordshire Beacon, near Malvern, which in 1880 I correlated with the Salopian pre-Cambrians? Professor Bonney and the Rev. E. Hill have demonstrated that the Charnwood clastics are of volcanic origin, and Mr. Allport has done the same for the Uriconian of Shropshire. Both in hand-specimens and in microscopic slides the rocks of Charnwood and of Shropshire evince the most marked similarity. The slates and grits of the Lower Cambrian of North Wales, on the other hand, are ordinary sediments. Macroscopically, they are somewhat like the Charnwood clastics; microscopically, they are widely different. As Sedgwick and Jukes did not study these rocks under the microscope, they were naturally unaware of this difference. Professor Hull has survived to a happier epoch, and he can judge for himself. He would also find it an interesting task to study the basal Cambrian strata that Professor Lapworth has discovered in Warwickshire, and the volcanic rocks that underlie them. After he has done so, he will find it hard to believe that the shales and quartzites of Nuneaton are the equivalents of the ash-beds and agglomerates of Charnwood. Why Professor Hull should go 90 miles off to correlate the Charnwood clastics with rocks which but superficially resemble them, when he can find formations that really do resemble them within half that distance, is a problem that I must leave the Professor himself to solve. C. CALLAWAY.

SANDORE, WELLINGTON, SALOP, *8th February*, 1895.

DESTRUCTION OF ECCLES CHURCH, ON THE NORFOLK COAST.

SIR,—An ancient landmark on the coast of Norfolk, one well known to readers of Lyell's "Principles of Geology," has been destroyed by the breakers during a severe storm, on January 23rd of this year. The old tower of Eccles church has for many years remained as a witness to the destruction of our shores. Since the Conquest, the greater part of the village of Eccles, between Happisburgh and Winterton, has been destroyed. The church itself was abandoned nearly three hundred years ago. In 1833, as noted by Samuel Woodward, its remains were still to be seen partially buried, as it were, within the "Marram Hills" or sand-dunes. In 1862 the hillocks of sand were drifted further inland, and the tower of the church was left standing on the foreshore, several yards below high water-mark, with the basement portion of the nave still showing in places amid the beach sand and shingle. Now the sea has beaten down the tower. It fell in a north-westerly direction in the very teeth of the gale, the sea breaking furiously against the

edifice, and the spray at times going over its summit before the final catastrophe. Huge masses of masonry now lie about in strange confusion to mark the spot where once stood this famous church; but ere long probably every vestige of it will be obliterated.

NORWICH.

A GLACIAL COMMITTEE FOR NORTH AMERICA AND EUROPE.

SIR,—The following are the names of members of the International Glacial Committee created at Zurich last summer. The list is to be completed by representatives of Russia and Italy.

COUNTRIES.	NAMES.	ADDRESS.
United States, N. America	Prof. Dr. F. Reid	Baltimore.
Austria	Prof. Dr. Richter	Graz.
Germany	Prof. Finsterwalder	Munich.
France	Prince Roland Bonaparte	Paris.
Switzerland	Prof. F. A. Forel and Dr. Leon du Pasquier (as Secretary).....	Morges.
Denmark	Dr. K. I. V. Steenstrup...	Copenhagen
Norway.....	Dr. A. Ojen	Christiania
Sweden.....	Dr. Svenonius.....	Stockholm
Great Britain	Capt. Marshall Hall	Easterton Lodge, Parkstone, Dorset.

The committee has powers to adopt its own organization, and is to report to the General Committee of the Congress, which was invited by the late Tsar to meet at St. Petersburg. Prof. Forel is the Organizing Secretary.

MARSHALL HALL.

EASTERTON LODGE, PARKSTONE, DORSET.

MR. ROBERT ETHERIDGE, Jun., formerly of the Geological Department in the British Museum (Natural History), and who for the last few years has occupied the position of Palæontologist to the Museum and the Geological Survey of New South Wales, Sydney, was appointed on the 1st of January to the office of Curator of the Australian Museum, Sydney, N.S.W., in the place of Mr. E. P. Ramsay, F.L.S., F.G.S., who has retired, having been in failing health for some years. Mr. R. Etheridge, jun., has distinguished himself both in this country and in Australia by his scientific researches, and has just been awarded the Clarke Medal from the Royal Society of New South Wales for his contributions to Australian geology.

With deep regret we have to record the death of Mr. J. W. HULKE, F.R.S., Foreign Secretary of the Geological Society of London, which took place on February 19th, after a brief illness. In addition to his great scientific abilities, and his distinguished position as a surgeon, he had endeared himself to a wide circle of friends by his amiable personal qualities. We hope to give a suitable notice of his scientific work in the April Number.